THERMAL HYDROLYTIC STUDIES OF POPLAR *(Populus nigrcr)* FOR THE PRODUCTION OF FURFURAL AND ACTIVE CARBON

Misbah Salam', Zill-i-Huma Nazfi", Fiyyaz Ahmad Chughtai' & Shomila Yourris'
'Department of Chemistry, University of Agriculture, Faisalabad
'Department of Chemistry, Govt. College for Women, Madina Town, Faisalabad

Cellulosic and carbonaceous materials on hydrolysis and activation yield furfural and active carbon compounds of high utility. Poplar *(Populus nigra)* was hydrolyzed with various concentrations of sulphuric and hydrochloric acids to get furfural. The residue left after the extraction of furfural was directly activated at 700°C to produce active carbon. The prepared carbon was checked for its adsorption capacity using iodine and methylene blue. Significant yields of high quality furfural and active carbon were obtained. Furthermore, sulphuric acid proved to be a better hydrolyzing agent as compared to hydrochloric acid.

Key words: active carbon, furfural, hydrochloric and sulphuric acids, poplar

INTRODUCTION

In recent years attention has been focussed on the utilization of waste vegetative materials as a potential source of commercial chemicals such as furfural and active carbon. These chemicals find multitudinous applications in various industries and still the scope is widening. Agro-industrial wastes and other vegetative materials are commonly available in Pakistan, but such materials have not been exploited properly. Recently some indigenous materials have been recognized as potential sources of furfural and active carbon (Khan and Nawaz, 1983; Chughtai et al., 1985, 1986, 1989, 1996 and Beg and Usmani, 1985).

Furfural and active carbon are extensively used in pharmaceutical, petroleum, synthetic fibre vegetable oil, fertilizers, beverages, food, textile, ceramics, chemicals and in many other important industries. A number of successful attemps have been made to exploit different vegetative materials such as Sarkanda, Khabble grass, Kai and Dhabb for the production of furfural and active carbon. In continuation of previous work, the present investigations demonstrate the effect of various hydrolyzing agents like H_2SO_4 and HCl on the quality of furfural and active carbon from poplar, one of the fast growing plants in climatic regions varying from temperate to subtropical which presently finds its use in soil reclamation, for making match sticks and as fuel.

MATERIALS AND METHODS

Preparation of Stock Sample: Poplar was collected from University fields, washed with tap water, ground to a fine mesh, dried to a constant weight in an electric oven at 110°C and stored in a desiccator asa stock sample.

Furfural: The stock sample (50g each) was refluxed with 500 ml of various concentrations (14 and 16% w/v) of commercial hydrochloric and sulphuric acids, separately for 100 and 140 minutes. The refluxsd material was distilled and the distillate thus obtained was re-distilled. The distillate was collected till it gave red colour with aniline acetate. Thereafter the furfural was separated from its aqueous solution according to Chughtai et al. (1986).

Active Carbon: The residue obtained after the recovery of furfural was dried and directly activated at 700°C for one hour in a muffle furnace. The material thus obtained was cooled to room temperature, weighed and ground to a fine powder. The adsorption capacity of the resulting activated carbon was tested with iodine and methylene blue (Beg and Usmani, 1985) and was compared with reference activated carbon.

RESULTS AND DISCUSSION

From the data presented in Table 1, it is evident that percentage yield of furfural, for each concentration of hydrochloric and sulphuric acids, increased with increasing digestion time. This observation is in harmony with the fmdings of Filotova and Korolkov (1976) and Sharma and Sahgal (1983) who reported that percentage yield of furfural increased with time and then decreased after reaching a maximum value.

Keeping in view the effect of acid concentration it is clear from the study that both acids i.e. hydrochloric and sulphuric acids behaved differently (Table 1). An increase in the yield of furfural was observed treatment. This probably was due to reduced competition for resources with these treatments compared to control. These results agree with those reported by Rafey et al. (1989).

Number of Spikelets Per Panicle: The number of spikelets panicle'l was significantly affected by the planting method. Transplanting significantly increased the number of spikelets per panicle over the direct seeding method by 31.32% (124.53 vs 85.53) (Table 1). Different nitrogen levels also significantly affected the number' of spikelets per panicle linearly. Among the fertilizer levels, the application of 100 kg N ha" produced the higher number of spikelets panicle" (124.65) followed by those with 50 kg N ha' and 0 kg N ha' which produced 105.41 and 85.03 spikelets per panicle, respectively. The maximum number of spiekelets panicle" obtained using transplanting could be due to sufficient amounts of moisture and nutrients available to the plants due to deep penetration and wide spread of roots at the panicle initiation and flowering stages, which eventually resulted in more panicle bearing and more number of spikelets panicle,l. The plants in direct sowing method were at disadvantage due to being shallow-rooted and high infestation of weeds which further reduced the availability of moisture and nutrient to the plants.

1000.Grain Weight: Thousand grain weight was not affected by planting methods. The average weight varied between 16.94-17.19 g/1000 grains in transplanting and direct seeding, respectively. However, different 'levels of nitrogen significantly affected the 1000-grain weight and this response was linear (Table 1). The overall 1000-grain weight was 17.06 g. These results do not agree with those reported by Singh et al. (1981) who showed higher grain weight in transplanting than direct seeding. Barner (1985) reported that application of 132 kg N ha" increased 1000-grain weight. Results of the present study show that transplanting along with 100 kg N ha" is the appropriate technology for obtaining higher paddy yield under Faisalabad conditions.

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Table 1. Effect of planting methods and nitrogen levels on yield and yield components of Basmati-385

	Paddy yield (t ha")	Total biomass (t ha")	Harvest index	No. of productive tillers hm[l]	No. of spikelets panicle"	1000-grain weight (g)
Planting method						
Direct sowing	2.30b	7,46b	0.31	8.30b	85.53b	17.19
Transplanting	2.77a	8.54a	0.33	14.51a	124.53a	16.94
Nitrogen level						
OkgNha'1	1,91c	6.28c	0.31	'8.51c	85.03c	15.70c
50 kg Nha'l	2.66b	7.98b	0.34	10.91b	105,41b	17.09b
100 kg N ha'l	3.03a	9.74a	0.31	14.78a	124.65a	18,40a
Linear	**	**	NS	**	**	**
Quadratic	NS	NS	NS	NS	NS	NS
Mean	2.53	8.00	0.32	11,40	105.03	17.06

Values in the same column having different letters differ significantly <p'~0.05).

respectively. All phosphorus and potassium and half of nitrogen was applied at the time of sowing and remaining half of nitrogen was applied one month after transplanting. All other agronomic operations except those under study were kept normal and uniform for all the treatments.' Standard procedures were adopted for recording the data on various growth and yield parameters. Data collected on paddy yield and yield components were analysed statistically. LSD test was applied for comparison of means (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Paddy Yield: Data presented in Table 1 showed that transplanting gave significantly higher paddy yield (2.77 t ha") than direct seeding (2.30 t ha'). Increasing the nitrogen rate also significantly enhanced paddy yield, showing a linear response. The paddy yield was 1.91, 2.66 and 3.03 t ha" in control, 50 kg and 100 kg N ha", respectively. Overall average paddy yield of 2.53 t ha" was observed. Maximum paddy yield was obtained in transplanting at higher rates of N application. This contributed to effect lesser sterility, lesser abortive kernel and higher grain weight and thus higher yield. These results are supported by those of Singh and Singh (1993) and Maqsood (1998).

Total Biomass Yield: Total biomass yield was affected significantly by planting method. Transplanting increased total biomass yield to 8.54 t ha" than direct seeding method (7,46 t ha'I). Increasing rates of N application also influenced total biomass yield with a linear trend. The use of 100 kg N ha" gave the maximum total biomass yield of 9.74 t ha', The treatment 50 kg N ha" gave the total biomass yield of 7.98 t hal.whereas the minimum yield was produced by the control treatment. Generally, TDM increased with transplanting or with increasing nitrogen rates. Similar results were reported by other workers (Hussain et al., 1989, Irshad ,1996 and Maqsood ,1998).

Harvest Index: Planting methods and nitrogen levels did not affect the harvest index. Similarly, the interaction between the planting method and nitrogen levels did not show any difference. Higher harvest index apparently was recorded in transplanting than with direct seeding and 100 kg N ha" but the differences did not attain the level of significance.

Number of Productive Tillers mll,l: Transplanting produced significantly more productive tillers hiU-[1] (14.51) than direct seeding (8.30). Different nitrogen levels also significantly affected the number of productive tillers hill,l showing a linear response. The maximum number of tillers (14.78) was recorded with the application of 100 kg N ha" followed by 50 kg N ha" (10.91) and 0 kg N ha'l (8.51), respectively. Application of N at enhanced rates led to the production of more tillers than with control

Pak. J. Agri. Sci. Vo.l. 37(1-2),2000

EFFECT OF DIFFERENT PLANTING METHODS AND NITROGEN LEVELS ON GROWTH AND YIELD OF RICE (BASMATI-385)

Muhammad Jamil & Abid Hussain
Department of Agronomy, University of Agriculture, Faisalabad

Field studies were conducted to evaluate the effect of two planting methods i.e. transplanting and direct seeding and three levels of nitrogen i.e. 0, 50 and 100 kg N ha^{-1} on growth and yield of rice (Basmati-385) during the year 1998. The experiment was laid out in a randomized complete block design with split plot arrangement having 4 replications and a net plot size of 2 x 3 m. Yield and yield components were significantly affected by different planting methods and nitrogen levels. Transplanting produced significantly higher paddy and total dry matter yield (2.77 t ha^{-1} and 8.54 t ha^{-1}) than with direct sowing method (2.30 t ha^{-1} and 7.46 t ha^{-1}) but planting methods had no effect on harvest index. Among nitrogen levels, 100 kg N ha^{-1} resulted in maximum paddy and total biomass yield of 3.03 and 9.74 t ha^{-1}, respectively.Transplanting produced significantly more number of productive tillers per hill, more number of spikelets per panicle than direct sowing but planting method had no effect on 1000-grainweight. Among nitrogen levels 100 kg N ha^{-1} resulted in maximum number of tillers per hill, spikelets per panicle and 1000-grainweight than rest of the nitrogen levels.

Key words: Basmati-385, growth and yield, nitrogen levels, planting methods

INTRODUCTION

Rice *(Oryza sativa* L.) is an important cereal crop of the world and nearly more than half of the global population subsists on it. In Pakistan, it occupies second position after wheat, the staple food of the people. It supplies more calories than any other cereal. In addition, this crop plays a significant role in the economy of Pakistan as it contributes annually about Rs.18453 millions to the total national foreign exchange earnings (Anonymous, 1997). Transplanting and direct seeding are the two general methods used for rice planting. Although transplanting is the common method of rice production but it is more laborious, cumbersome, time consuming and entails a lot of expenditure on raising nursery, its uprooting, transporting etc., whereas for direct seeding only two man hours are required for the same area (Hashimoto et al., 1976). Careless transplanting by hired labour results in low planting densities in the farmer's field. The scarcity and high cost of farm labour invariably delay transplanting and often lead to the use of aged seedlings (Santhi et al., 1998). Nitrogen is the most important nutrient for rice plant as it is required at much higher rates than other macro nutrients such as phosphorus and potash.

Increasing rate of nitrogen application significantly enhanced both paddy yield and TDM yield over control or lower rate of nitrogen application (Maqsood et al., 1998). Moreover, plant height, panicle length, tillers per hill and panicle bearing tillers per hill were also significantly affected by nitrogen application and 100 kg N ha^{-1} was found to be an appropriate dose (Irshad, 1996). The application of nitrogen fertilizer either in excess or less than optimum rate deteriorates both yield and quality of rice to a remarkable extent. Thus proper management of crop nutrition is of immense importance. The present study, was, therefore, designed to compare the direct seeding technique with transplanting method and to investigate the effect of different nitrogen levels on rice (Basmati-385) and to determine the appropriate planting method and level of nitrogen that could help in achieving suitable paddy yield.

MATERIALS AND METHODS

The experiment was conducted at the Agronomic research. area, University of Agriculture, Faisalabad during the year 1998. The experiment was laid out in a randomized complete block design with split plot arrangement and four replications. The plot size was 2m x 3m. The treatments comprised two planting methods viz. transplanting and direct seeding and 3 nitrogen levels viz. 0(N_0), 50 (N_1) and 100(N_2) kg N ha^{-1}. Different planting methods were placed in main plots while different nitrogen levels were allocated to the subplots. The nursery for raising seedlings was sown in the first week of June and transplanting was done in the first week of July. At the same time, 24 hours water-soaked paddy seeds were sown direct by drill. There were 8 rows on each plot having row to row distance of 25 cm. Seed rate of 60 kg ha^{-1} was used for direct-seeded rice. Phosphorus and potassium were applied @ 67 and 62 kg ha^{-1}, of NM-92 to utilize the environmental sources for producing heavier seeds. The results conform to those of Ayub et al. (1999) and Sharar et al. (1999) who also reported significant differences among cultivars for 1OOO-seed weight. However, the effect of inoculation on 1OOO-seed weight was found to be non-significant. The two sources of inoculation, NIBGE and AARI inoculants, also produced statistically similar results for 1OOO-seed weight.

5. Seed Yield (kg ha'): The three genotypes did not differ significantly in seed yield due to statistically similar number of pod bearing branches plane, number of pods plane and number of seeds pod'. Seed yields of inoculated and uninoculated treatments significantly differed from each other. Maximum seed yield (1119.73 kg ha") was obtained in plots where NIBGE inoculant was applied. This was, however, statistically similar to the seed yield obtained by AARI inoculant (1057.76 kg ha"). The minimum seed yield was observed in uninoculated control. Similar results were obtained by Brar and Lal (1991) and Saimnazarov et al. (1995) who also found an increase in seed yield with inoculation.

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Table 1. Response of three mungbean genotypes to different sources of seed Inoculatton

	No. of pod bearing branches per plant	No. of pods per plant	No. of seeds per pod	IOOO-seed weight (g)	Seed yield (kg ha-1)
Genotypes					
NM-51	5.92[NS]	18.87[NS]	9.97[NS]	51.61b	974.69[NS]
NM- 54	5.96	16.98	10.78	52.04ab	987.14
NM- 92	6.05	19.57	10.90	52.63a	1012.18
Seed inoculant					
Uninoculated	5.73b	16.80c	8.73c	51.58[NS]	796.53b
NIBGE inoculant (Biopower)	6.18a	21.59a	12.01a	52.43	1119.73a
AARI inoculant	6.01a	19.92b	10.37b	52.28	1057.76a

Means followed by the same letters did not differ significantly at 5% probability leveL

plane, average number of pods plane and average number of seeds pod', From each plot 1000 seeds were counted and weighed to' determine the 1000-seed weight. Seed yield obtained from each plot was converted to kg ha'. Data collected were analysed statistically using Fisher's analysis of variance technique and the least significant difference .test at 0.05 probability level was employed to compare the difference among the treatment means (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

The data recorded regarding various parameters are given in Table 1.

1. Number of Pod Bearing Branches Plane: There was no significant difference observed among the genotypes for number of pod bearing branches per plant. This similarity can be attributed to the similar genetic traits of crop plants. Khan et al. (1999) has also reported non-significant difference among the mungbean cultivars. Number of pod bearing branches were significantly affected by the use of inoculant over the uninoculated controL This might be due to inoculation' which resulted into enhanced vegetative growth. However, the two inoculants, NIBGE and AARI, produced statistically similar number of pod bearing branches plane. Significant increase in the number of pod bearing branches by inoculation was also reported by Brar and Lal (1991).

2. Number of Pods Pf ant': Non-significant difference was observed in the number of pods plane of the three genotypes. However, inoculation significantly increased the number of pods plane over uninoculated controL Inoculation might have enhanced the enzymatic activity which controlled pod formation. The plots which were treated with NIBGE inoculant produced statistically higher number of pods plane (21.59) than those treated with AARI inoculant (19.92). The results are in line with those of Pandher et al. (1991) who also reported an increase in number of pods plane by inoculation with different strains of Rhizobium.

3. Number of Seeds Pod'l: The three genotypes did not differ significantly with regard to number of seeds pod-'. Khan et aL (1999) has also reported similar results. However, inoculation significantly increased the number of seeds pod" over uninoculated controL This was attributed to the fact that inoculation increased nodulation, improved the utilization of atmospheric nitrogen and enhanced the phosphorus availability to the plants. The plots which were treated with NIBGE inoculant produced statistically more number of seeds pod'! (12.01) than those treated with AARI inoculant (10.37). Thakur and Panwar (1995) also found an 'increase in dry matter production of mungbean with inoculation.

4. IOOO-SeedWeight (g): Significant differences were observed among the three genotypes for, 1000-seed weight. Maximum seed weight (52.63 g) was found in genotype NM-92, which was, however, statistically at par with that of NM-54 (52.04g), which in turn did not differ significantly from that of NM-51 (51.61g). This increase in 1000-seed weight could be because of greater genetic potential

Pak. J. Agri. Sci. Vol. 37(1-2), *2000*

RESPONSE OF MUNGBEAN *(VIGNA RADIATA* L.) GENOTYPES TO RHIZOBIA CULTURE

Asghar Ali, M. Adil Choudhry & Asif Tanveer
Dept. of Agronomy, University of Agriculture, Faisalabad

Response of three mungbean genotypes namely NM-51, NM-54 and NM-92 to seed inoculation from two different sources (NIBGE inoculant and AARI inoculant) was studied under field conditions. The growth and yield components like number of pod bearing branches per plant, number of pods per plant, number of seeds per pod and 1000-seed weight were significantly affected by inoculation. Treatment of seeds with NIBGE inoculant (Biopowar) gave significantly more seed yield as compared to that with AARI inoculant. The three genotypes, however, produced statistically similar growth and yield components except 1000-seed weight which was maximum in NM-92 genotype.

Key words: mungbean genotypes, Rhizobia culture

INTRODUCTION

Mungbean *(Vigna radiata* L.) is one of the most important conventional pulses grown in Pakistan. It was cultivated on an area of 195.4 thousand hactares with a total production of 88.9 thousand tonnes giving an average yield of 455 kg ha^{-1} (Anonymous, 1999). It plays an important role not only in human diet, but also in improving soil fertility by fixing atmospheric nitrogen into available form with the help of Rhizebia species present in the nodules of its roots. However, under our agro-ecological conditions, the nodulation of mungbean is poor which is the major cause of its low yield. It was observed that inoculation of mungbean with Rhizobium increased plant height, leaf area, photosynthetic rate and dry matter production (Thakur and Panwar, 1995). Brar and Lal (1991) found an increase in number of nodules plane and seed yield with inoculation. They obtained seed yield of mungbean ranging from 0.76 t ha^{-1} without seed inoculation to 0.81 t ha^{-1} with *Rhizobium phaseoli* inoculation. similarly, Pandher et al. (1991) reported that inoculation of mungbean with single and multiple strains of Rhizobium increased the number of root nodules and seed yield. Sarkar et al. (1993) reported that seed inoculation of mungbean with Rhizobium + *Azotobacter chroococcum* and *Rhizobium* + *Azopirillum brasilense* produced statistically similar seed yield. Similarly, Tripathi et al. (1994) obtained the seed yield of mungbean with Rhizobium inoculation similar to that of 20 kg N ha^{-1}. Saimnazarov et al. (1995) inoculated the seeds of mungbean cultivars with two Rhizobium strains, 1901 and 33 and found an increase it).seed yield with both strains.

Varieties of mungbean vary in yield and yield components (Sharar et al., 1999). Ayub et al. (1999) obtained significantly higher seed yield of mungbean cv. NM-92 over NM-54 due to higher number of pod bearing branches plane, number of pods plane and number of seeds pod', However, Khan et al. (1999) found no statistical difference between the yield components of mungbean cultivars under observation. After having known about the effect of inoculation and variable varietal behaviour, the present study was undertaken to determine an appropriate source of Rhizobium inoculation for mungbean and also to compare the growth and yield performance of three mungbean cultivars under agro-ecological conditions of Faisalabad.

MATERIALS AND METHODS

The experiment was carried at the Agronomic research area, University of Agriculture, Faisalabad, during the year 1996, on a sandy clay loam soil having 0.085% nitrogen, 9.2 ppm available phosphorus and 134 ppm available potassium. The experiment was laid out in a split plot design with four replications having a net plot size of 1.5 m x 6.0m. Rhizobium inoculum treatments (uninoculated, NIBGE inoculant and AARI inoculant) were randomized in main plots while mungbean genotypes were randomized in subplots. The whole quantity of nitrogen and phosphorus @ 20 and 60 kg ha^{-1}, respectively was side-dressed at sowing time. The crop was sown in second weak of August in 30 cm apart rows with a single row hand drill. It was harvested in the third weak of October when about 80% of pods had attained maturity. Ten plants from each plot were selected at random to record average number of pod bearing branches

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sprayer CP-3 having a boom of 1.8 m fitted with 4 T-Jet nozzles adjusted at a distance of 45 cm each was used for the purpose. In all chemical treatments, 500 litres of water per hectare was used. In hand-weeding treatment, two hoeings were given, each after last 1992 and 1993 irrigation. All other agronomic practices were kept uniform. Observations on weed dry weight, viable nodules and grain yield were recorded during the growing season. Herbicides used in this study were new and were not marketed in Pakistan. The data were analysed using analysis of variance and multiple comparison was made where necessary to test the significant difference of treatment means (Muhammad, 1995).

RESULTS AND DISCUSSION

Dry weight of weeds is a better criterion of the weed-crop competition than the weed density. Higher dry weight of weed reflects more utilization of soil and environmental resources by the weeds at the expense of the crop. Data on weed's dry weight in various weed control treatments showed significant differences (Table 1). In 1992 year, the lowest weed dry weight (3.74 g m") was recorded in plots where two hand-weedings were given each after 1992 and 1993 irrigation. Non-significant difference in weed dry weight was recorded among each other in plots treated with both herbicides at both levels. These weights were significantly lower than weed dry weights recorded in weedy check plots. The highest dry weight of weeds (86.79 g m") was recorded in weedy check treatment. Data for the 1993 year showed almost similar trend.

Data presented in Table 1 indicated that the differences among treatment means were not significant in both the years under study. It appears that herbicide application did not affect the nodulation activity of mungbean plants.

Grain yield per hectare is the major economic part of plant which is affected to a varying degree by contribution from yield components. The data presented in Table 2 showed that grain yield was affected significantly by various weed control treatments in both the years of study. Highest grain yield of 1380 and 1395 kg ha'! was obtained with hand-weeding in year 1992 and 1993, respectively. It was followed by *Fluazifop-butyl* applied at the rate of 2.0 and 3.0 I ha'! and *Fenoxaprop-p-ethyl* at the rate of 1.0 and 1.25 I ha'! producing grain yield from 1322 to 1343 kg ha", In 1992 hand-weeding was significantly effective while in 1993 the results were non-significant. This was attributed to effective weed control potential of these herbicides. Both the herbicides at each dose were effective in controlling weeds. The lowest grain yields of 960 and 979 kg ha'! in year 1992 and 1993, respectively were recorded in weedy check plots. The percentage increase in grain yield in weed control treatments over the weedy check ranged between 37.8 and 43.8 in year 1~92 and 37.5 and 42.5 in 1993. Yield components like pods per plant, number of grains per pod and 1000-grain weight contributed positively towards final yield. Balyan and Malik (1989) also found higher grain yield with the application of herbicides in mungbean.

Table 1. Efficacy of *Fluazifop-butyl* (Fusilade 25 EC) and *Fenoxaprop-p-ethyl* (Puma-S 69 EW) for weed control in mungbean and effect on weed dry weight and viable nodules

Treament	Dose (Iha'!)	Weed dry weight (g m") 1992	1993	Viable nodules (per plant) 1992	1993
Weedycheck	-	86.79 a	93,29 a	33.68 b	36.34~
Hand-weeding	-	3.74 e	6.41 d	42.69 a	40.99'
Fluazifop-butyl	2.00	15.02 b	19,08 be	39.38 ab	40.81
Fluazifop-butyl	3.00	14,25 b	18,28 e	37,42 ab	39.38
Fenoxaprop-p-ethyl	1,00	14.18 b	20.96 be	40.64 a	40,49
Fenoxaprop-p-ethyl	1.25	15.05 b	23.74 b	36.53 ab	45.57

Means not sharing a letter in common differ significantly at 0.05 probability; N.S. = Non-significant.

Table 2. Efficacy of *Fluazifop-butyl* (Fusilade 25 EC) and *Fenoxaprop-p-ethyi* (Puma-S 69 EW) for weed control in mungbean and effect on grain yield

Treatment	Dose (I ha,I)	1992	% increase over control	1993	% increase over control
Weedy check	-	960 c	-	979 b	-
Hand-weedina	-	1380 a	43.8	1395a	42.5
Fluazifoo-butvl	2.00	1322b	37.8	1354a	38.3
Fluazifoo-butvl	3,00	1343b	39.9	1361 a	39.0
Fenoxaoroo-o-ethyl	1,00	1334 b	39.0	1346 a	37,5
FenoxaoroD-D-ethyl	1,25	1340b	39.6	1347 a	37.6

Means not sharing a letter in common differ significantly at 0.05 probability.

Conclusions: Grain yield significantly varied among different treatments and was maximum in hand-weeded plots. Lower rates of herbicides were as effective in increasing grain yield as the higher rates. Grain yield in weed control plots was 37.8 to 43.8 % higher than weedy check.

Pak. J. Agri. Sci. Vol. 37(1-2),2000

EFFICACY OF *FLUAZIFOP.BUTYL* (FUSILADE 25 EC) AND *FENoXAPROP. P.ETHYL* (pUMA·S 69 EW) FOR WEED CONTROL IN MUNGBEAN

Muhammad Naeem, Saeed Ahmad[1] & Hakoomat Ali
College of Agriculture, D. G. Khan and [1]Department of Agronomy, University of Agriculture, Faisalabad

The study was conducted to find efficacy of *Fluozifop-butyl* and *Fenoxaprop-p-ethyl* applied post-emergence on mungbean. The mungbean *(Vigna radiata* (L) Wilczek) is a short duration, early maturing legume crop, whicb can fit well in tbe prevalent cropping system. Dry weigbt of weeds was maximum in weedy cbeck plots. The best weed control was found in band-weeding treatment hence weed dry weigbts were also minimum. Grain yield significantly varied among different treatments and was maximum in band-weeding. Application of *Fluozifop-butyl* or *Fenoxaprop-p-ethyl,* post-emergence berbicides at lower dose was as effective as at bigber rate. Increase in grain yield due to weed control was up by 45 % over weedy plots throughout the growing season.

Key words: herbicides, mungbean, weed control

INTRODUCTION

pulses are important world food crops because they provide a cbeaper source of vegetable protein. The mungbean *(Vigna radiata)* containing 24 % protein (Poehlman, 1991) is a drought tolerant, legume crop, which can fit well in the prevalent cropping system. It is grown in Pakistan on 197.6 thousand hectares with a production of 91.2 thousand tonnes of grain annually giving an average yield of 461.5 kg per hectare (AnonymouS, 1998) which is much below the potential of our existing varieties. Abmad (1992) assessed that annual losses of food crops caused by weeds may be more than 10 billion rupees. Due to high competitive ability and high reproductive potential of weeds,. it is imperative to check their infestation. Moreover, intertillage with conventional tillage implements is quite difficult. It is labour intensive, uneconomical, weather dependent and crop damaging. It is very difficult to control weeds with methods other than chemical control. Chemical weed control is a quick method to control dense weed populations. The rate of herbicide application should be adjusted to give maximum weed control without significant injury to mungbean plant. Application rates in excess of those needed for effective control of weeds, cause unnecessary rise in production costs, increase the potential for injury to the mungbean plant, and enhance the risks of environmental contamination. A shift in weed flora from broad leaved to grassy weeds has been observed during past few years. A good number of new selective herbicides have been introduced in the country to combat weed problem. Performance of herbicides should be tested in the area of intended use before their adoption. Thus, their testing and evaluation under our conditions is necessary for their rational use. This experiment was aimed at studying the efficacy of two newly introduced herbicides Le. *Fluazifop-butyl* (Fusilade 25 EC) and *Fenoxaprop-p-ethyl* (Puma-S 69 EW) applied post-emergence at two different rates.

MATERIALS AND METHODS

Studies on weed management for mungbean were carried out at the Agronomic research area, University of Agriculture, Faisalabad during spring of 1992 and 1993. The experiment was conducted on a field heavily infested with important grassy weed flora. The weed seeds were broadcast and incorporated in each plot before sowing mungbean to ensure uniform stand of weeds. The study involved four replications and net plot measured 1.8 x 6 m. The mungbean variety 'NM-54' was sown in six rows 30 cm apart. Experimental plots were sown manually with a single row hand drill using 25 kg seed per hectare. Three irrigations, each of 75 mm, were applied. in addition to 47.6 and 59.5 mm rain received during the growing season of 1992 and 1993, respectively. All other cultural practices, except the treatments, were uniform for all the plots. Treatments under trial were weedy check, hand-weeding, and the application of *Fluazifop-butyl* (Fusilade 25 EC) @ 2.0 1 ha'\ *Fluazifop-butyl* (Fusilade 25 EC) @ 3.0 1 ha'\ *Fenoxaprop-p-ethyl* (Puma S 69 EW) @ 1.0 1 ha,l and *Fenoxaprop-p-ethyl* (Puma S 69 EW) @ 1,25 1ha,l. The herbicides were sprayed 21 days after crop sowing, and the soil was in proper moisture condition. Knapsack hand

Available Phosphorus

Status	Value (mg kg")	Colour intensity (%) (developed after the test)
i) Low (deficient)	0-5	5,10,20
ii) Medium (sufficient)	5-10	30,40,45
iii) High (adequate)	> 10	60,80,100

pH Value (Depending upon intensity of the sample colour and its comparison with standard colour chart):

i) S 8.0, ii) 8.2, 8.4, 8.5, and iii) 8.6, 8.8, 9.0

- If pH of the soil is :::8.0, then all the nutrients are easily available to plants except Fe, Mn, and B which become less available.
- If pH is 8.0-8.5, then phosphorus and micronutrients are available at a low level except Mo.
- If pH is ~ 8.5, then there exists problem of alkalinity. Then detailed analysis of such soils is done in the laboratory for gypsum requirement (GR).

RESULTS AND DISCUSSION

Yearwise detail of the samples (22,948) analysed by soil testing kit has been given in Table 1. The data show that 18.10 % ofthe samples had pH::; 8.0, while that of majority of samples (80.35 %) ranged between 8.0 - 8.5, whereas 1.55 % had pH more than 8.5. Similarly, 90.30 % of samples had available phosphorus < 5 mg kg", 9.32 % had 5-10 mg kg'! and only 0.38 % samples had> 10 mg pp; kg'! soil.

Fertilizer recommendations were provided to the farmers on the basis of soil tests. It was reported that pH of the soil increased a bit upon initial application of the fertilizers but later on it declined towards neutral due to soil buffering capacity. Thus there is no apprehension in this regard and it is advised to use any type of fertilizer which is available in the market. For' promoting the use of phosphatic fertilizers, the following recommendations were made (Table 2). The number of required bags (50 kg weight) can be calculated according to the percentage of available phosphatic fertilizer (SSP = 18 %, NP = 23 %, DAP and TSP = 46 % PPs, respectively). Maximum benefit from phosphatic fertilizers can be achieved if used at the time of sowing. These fertilizers have residual effect and subsequent crops are benefitted if full dose of P_2O_5 fertilizer is applied to the previous crop which utilizes only 18 - 20 % of PPs. A large quantity of well-rotten farm yard manure may be applied or green manuring should be done to increase the efficiency of phosphatic fertilizers.

To boost up crop productivity at national level, the farmers should be educated about the useful role of phosphatic fertilizers.

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Table 1. Yearwise analyses of Attock soil samples using kit method

Year	Total samples	pH			Available phosphorus (mg kg')		
		< 8.0	8.0-8.5	> 8.5	0-5	5 -10	> 10
19Rn-Rfl	2nnn	R94	1fl24	~7	241~	142	-
1986-87	82'0	102	718	-	798	22	-
1987-88	1965	358	1590	17	1698	267	-
1988-89	2563	278	2215	70	2285	278	-
1989-90	1443	109	1310	24	1358	85	-
1990-91	1441	168	1255	18	1266	175	-
1991-92	988	88	878	22	896	92	-
1992-93	930	76	840	14	868	62	-
1993-94	673	126	532	15	603	62	8
1994-95	1803	428	1358	17	1683	106	14
1995-96	1930	410	1482	38	1606	306	18
1996-97	1392	274	1090	28	1240	140	12
1997-98	1897	380	1500	17	1708	163	26
1998-99	2548	463	2046	39	2300	238	10
Total	22948	4154	18438	356	20722	2138	88
%asre		18.10	80.35	1.55	90.30	9.32	038

Table 2. Fertilizer recommendations

Crops: Common names	Botanical names	Phosphorus (PPs) to be applied (kg ha") Native available P_2O_5 (kg ha")		
		0-12.5	12.5-25	> 25
Wheat	*Triticum aestivum*			
(Irrigated)		102.5	77.5	52.5
(Rainfed)		67.5	50.0	35.0
Gram	*Cicer arietinum*	67.5	50.0	35.0
Raya	*Brassica juncea*	67.5	50.0	35.0
Maize	*Zea mays*			
(Irrigated)		135.0	100.0	67.5
(Rainfed)		102.5	77.5	52.5
Groundnut	*Arachis hypogaea*	90	67.5	45.0
Potato	*Solanum tuberosum*	112.5	85.0	57.5
Sugarcane	*Saccharum officinaruni*	112.5	85.0	57.5
Cotton	*Gossypium hirsutum*	45.0	32.5	22.5
Lentil (Rainfed)	*Lens culinaris*	35.0	25.0	17.5
Pearl millet	*Pennisetum typhoides*	35.0	25.0	15.0

Source: Rapid Soil Fertility Survey and Soil Testing Institute, Lahore, Pakistan.

AVAILABLE PHOSPHORUS AND pH STATUS OF ATTOCK SOILS

Obaid-ur-Rehman[1], *A.A.* Sheikh[2] & **K.H.** G~112
[1]Soil and Water Testing Laboratory, Attock
[2]Directorate of Rapid Soil Fertility, Lahore

Some 22,948 soil samples obtained from farmers' fields were tested by kit method to find out available phosphorus (PPs) status and pH level during 1985-99. It was observed that pH of 80.35 % of analysed samples was between 8.0 - 8.5, while 90.30 % of samples had available P_2O_5 less than 5 mg kg" of soil. Fertilizer recommendations were provided to the farmers accordingly.

Key **words:** Attock soils, p~os:e~.?E!~_a_n_d_s p_H_u_s

INTRODUCTION

Fertilizer recommendations for efficient and economic crop production are based on soil testing as one of the essential factors. Soil tests in the laboratory include both for salinity and fertility appraisal but it is somewhat a lengthy process involving sample preparation and analyses for many parameters. Rapid assessment of soil with respect to available phosphorus and soil reaction (pH) is necessary and it is possible with the help of a soil testing kit.

Often pH is not a direct cause of poor plant growth but is associated with other factors e.g. AI or Mn toxicity or Ca, Mg or Mo deficiency which affect growth (Pearson, 1975). Phosphorus is more available at a soil pH 6.5-7.0 than at either higher or lower values (Hartmann et al., 1988). The difference in P availability at pH values between 7.2-8.1 was statistically non-significant .but P has synergistic effect with N, K and Mg while it is antagonistic with S, Zn, Mn and Fe (Ahmad et al., 1990).

The soils under high rainfall have lower pH values than those in irrigated areas, which are not saline and have low status P availability (Ahmad et al., 1988). pH is an important consideration in the selection of right type of phosphatic fertilizer. Superphosphate fertilizers do not appreciably affect soil pH, pH is also very much correlated with sodicity problem i.e. pH > 8.5 almost invariably indicates an exchangeable sodium percentage (ESP) > 15 and presence of alkaline earth carbonates and vice versa. Due to the intensive cropping, soil reserves of phosphorus are being depleted @0.23 mg kg' annum"; 17% soils have pH > 8.5 and 93 % soils are deficient in available phosphorus (Anonymous, 1994).

Phosphorus is absorbed by plants either as $H_2PO_4^-$ (when pH < 7) or as HPO_4^{2-}, (when pH > 7) and availability of phosphate and micronutrients (Fe, Mn, Cu, Zn, B) is impeded by high pH values (NFDC, 1996). Rehman et al, (1995) analysed 20,906 soil samples to determine fertility and salinity status of Attock district under advisory service Lu 1'!01-1U.t: fertilizer recommendation" tu the farmers according to the respective analysis ut the soils. Quickest methodology for phosphurusfertilizer recommendations was determined (Akram et al., 1993) and then it was found that soilP level of 15 mg kg" is suitable for acquiring 95 % relative yield of wheat (Akram et al., 1994).

MATERIALS AND METHODS

The whole area of district Attock was regularly surveyed by the laboratory staff every year and homogeneous composite soil samples from 6-8 sites up to a depth of 15 cm were taken by auger of 2.5 cm diameter and testing was at least duplicated. A chart with- coloured strips was used for matching the soil colour developed by adding 4-6 drops of thymol blue indicator for pH. If pH was > 8.5, then samples were brought to laboratory for detailed analysis. Similarly, a pinch of soil to be tested was taken in the depression ,of a procelain plate and 8-10 drops of borax solution, 1-2 drops of molybdic acid solution and one drop of stannous chloride solution were added to the sample respectively and allowed to stand for 30 seconds. The intensity of colour developed was compared with standard coloured chart (Malik et al., 1984).

Criteria: The following criteria for a nutrient were pointed out in a review by Rehman and Ghani (1990): When the crop yield was < 50 % of its potential and no fertilizer applied, the native nutrient level is low. If the yield is 50-75 %, then nutrient level is medium. Again if the yield is 100 %, the level is high. On these bases the following criteria were developed by Soil Fertility Department, Government of the Punjab for performing routine soil analysis at all district Soil Fertility Laboratories.

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Table 4. Effect of irrigation frequencies and fertilizer levels on pod length (cm) (average of four years data)

	Irrigation frequencies	Pod length (cm)			
		F1	F2	F3	Mean'
		0-0-0 kg NPKlha	27-92-0 kg NPKlha	54-184-0 kg NPKlha	
A1	One irrigation	12.56BC	12.54BC	11.80E	12.30B
A2	Two irrigations	12.29CD	12.25D	12.42CD	12.32AB
A3	Three irrigations	12.50BC	11.85E	12.65BC	12.33AB
A4	Four irrigations	10.45C	12.75B	14.65A	12.62A
	Mean	11.95C	12.35B	12.88A	

a single row hand drill in rows 30 cm apart on a well prepared seed bed. Plant to plant distance was maintained as 10 cm by thinning to obtain uniform plant population in each treatment. The crop was harvested during the 1st week of October each year. The data on number, of pods/plant, number of seeds/pod, pod length and grain yield were recorded. The data were analyzed using analysis of variance technique (Steel and Torrie, 1984). The original fertility status of the experimental soil on average was 0.03% N, 12.07 ppm PP5 and 137 ppm ~O and pH 8.00.

RESULTS AND DISCUSSION

Significant effects of irrigation frequencies and fertilizer levels were observed on grain yield. The highest grain yield of 1573.33 kg/ha was obtained with four irrigations (A4) followed by three irrigations (1465.49 kg/ha). The lowest grain yield (1234.14 kg/ha) was obtained with one' irrigation (Table 1). Similar results were reported by Bachchhar et al. (1993). Regarding fertilizer levels, the highest average grain yield (1710.53 kg/ha) was obtained with the application of 54-184-0 kg NPKlha followed by 27-92-0 kg NPKlha giving 1508.00 kglha. However, all the fertilizer treatments gave higher grain yield than control (1209.20 kg/ha) (Table 1). These results were supported by Hussain (1994).

The interaction between irrigation frequency and fertilizer level was also significant. The maximum grain yield (1980.37 kg/ha) was obtained from plots receiving four irrigations and fertilized @ 54-184-0 kg NPKlha.

Irrigation frequencies had significant effect on number of pods/plant (Table 2). The maximun. pods/plant (24.95) were recorded in plots irrigated four times during the crop season. Fertilizer application also showed significant effect on pods per plant. The maximum number of pods/plant (25.81) was produced by plants fertilized @ 54-184-0 kg NPKlha. Significant response of mungbean to irrigation and fertilizer application has also been reported by Bachchhar et al. (1993).

Data given in Table 3 revealed that the maximum number of grains/pod (17.95) was recorded in A4 treatment and was followed by A3 (15.34). One and two irrigations gave almost similar results. Maximum number of grains/pod (18.98) was produced by F3 treatment where fertilizer was applied @ 54-184-0 kg NPKlha. The interaction between both the factors was also significant. The highest number of grains/pod ,(23.50) was recorded in plots given 4 irrigations and fertilized @ 54-184-0 kg NPKlha.

The data on pod length showed significant increase in pod length with fertilizer application (Table 4), whereas irrigation frequencies did not have significant effect on pod length.'

These results led to the conclusion that irrigation at all critical stages along with combined application of nitrogen and phosphorus in appropriate proportion is important for getting high grain yield of mungbean cultivar NM-54 under irrigated conditions ofThal.

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Table 1. Effect of irrigation frequencies and fertilizer levels on grain yield of mung NM-54 (average of four years data)

	Irrigation frequencies	Grain yield (kg/ha)			
		F1	F2	F3	Mean
		0-0-0 kg NPK/ha	27-92-0 kg NPK/ha	54-184-0 kg NPK/ha	
A1	Onp. imP'RHnn	1001.f\7F	12Rl?2F.	141AFlOn	12:;14.14n
A2	Two irriaations	1041.13F	1480.80D	1649.55C	1390.49C
A3	Three irrieations	1015.45F	1588.34C	1792.69B	1465.49B
A4	~~llrUrieati~	lQ~u4F	16aL~	19&la7Jl	ua3~3A
	Mean	1029.20C	1508.00B	1710.53A	

Table 2. Effect of irrigation frequencies and fertilizer levels on number of pods/plant (average of four years data)

	Irrigation frequencies	Number of pods/plant			
		F1	F2	F3	Mean
		0-0-0 kg NPK/ha	27-92-0 kg NPK/ha	54-184-0 kg NPK/ha	
A1	One irrigation	12.15F	20.I~E	22.00D	18.nC
A2	Two irrigations	10.35G	23.48D	25.50C	19.77B
A3	Three irrigations	13.67F	22.85D	26.90B	21.14A
A4	Four irrigations	12.40F	24.95C	28.85A	22.85A
	Mean	12.14C	22.86B	25.81A	

Table 3. Effect of irrigation frequencies and fertilizer levels on number of grains/pod (average of four years data)

	Irrigation frequencies	Number of pods/plant			
		F1	F2	F3	Mean
		0-0-0 kg NPK/ha	27-92-0 kg NPK/ha	54-184-0 kg NPK/ha	
A1	One irrigation	8.50L	14.67G	15.38D	12.85D
A2	Two irrigations	9.35K	13.37H	17.21D	13.31C
A3	Three irrigations	10.47J	15.70E	19.85B	15.34B
A4	Four irrigations	12.361	18.00C	23.50A	17.95A
	Mean	10.17C	15.44B	18.98A	

Pak. J. Agri. Sci. Vol. 37(1-2),2000

STUDIES ON INTERACTIVE RELATIONSHIP OF IRRIGATION FREQUENCIES AND FERTILIZER LEVELS IN MUNG (NM·54) UNDER THAL CONDITIONS

Muham~ad Jamil, Abdus Sattar & Abdul Latif Malghani
Agronomic Research Station, Karor, District Layyah

Three fertilizer lev~ls (?-0-0, 27-92-0 and ~4-184-0 NPK kg/ha) and four irrigation frequencies (flowering stage; 30 days after germination (DA?) + flowenng stage; 30 DAG + flowering stage + pod formation stage; flowering stage + 3~ DAG + pod formation + 10 days after pod formation) were evaluated for yield potential of mung. M~g vanety. N~-54 was planted on a sandy loam soil during the four consecutive years (1996-99). The maximum gram YIeld (1573.33 kg/ha) was obtained with four irrigations and a fertilizer dose of 54-184-0 NPK kg/ha.

Key words: fertilizer levels, irrigation frequencies, mung (NM-54)

INTRODUCTION

Legume crops respond more to phosphorus than to nitrogen as compared to non-legume crops. Mungbean is the most important and widely cultivated crop of Thal. However, due to poor soil fertility, low varietal potential, mismanagement of irrigation and imbalanced use of fertilizers, its yield is not only stagnant but also below normal.. There is a common notion that legume crop does not need nitrogenous fertilizer for their proper growth. Contrarily, mung researchers have reported that application of both the nitrogenous and phosphoratic fertilizers increased the yield of mungbean. Misra and Gangwar (1987) reported that the highest grain yield of mungbean (1.26 t/ha) was obtained with 8 irrigations. Younis and Ahmad (1988) reported that under rainfed conditions, combined fertilizer application (30-60 NP kg/ha) gave higher seed yield of mungbean than sole application of phosphorus (0-60 NP kg/ha). Similarly, Sarwar (1988) concluded that different yield components of mungbean such as number of pods/plant, number of seeds/pod and 1000-grain weight increased significantly with the application of NPK fertilizer @ 30-90-30 kg/ha:

Sekhon et al. (1990)·studied the influence of different irrigation levels (2, 4 and 6) on the yield of summer mungbean and obtained seed yield of 0.49, 0.79 and 0.93 tJha with 2,4 and 6 irrigations respectively. Dewangan et al. (1992) observed that both the uptake of NP and grain protein contents of mungbean were enhanced with increasing irrigation frequency. Rajput et al. (1992) reported that application of 34-67-0 kg NPKlha gave higher seed yield (803 kg/ha) or mungbean than 0-50-0 kg NPKlha (694 kg/ha) under Bahawalpur conditions. Bachchhar et al, (1993) stated that mungbean irrigated at different critical growth stages i.e. branching, flowering, postflowering and pod development produced seed yield of 1.17, 1.34, 1.65 and 1.48 tJha respectively. Nitrogen uptake was also increased with an increase in irrigation frequency. Singh et al. (1993) reported that grain yield of mungbean was increased by the application of 20 kg N and 40 kg pps, whereas K application had no significant effect. Hussain. (1994) found that application of nitrogen alone or in combination with P and K increased significantly the number of seeds/pod, seed yield/ha over control. Since the soils of Thal region are generally deficient in nitrogen and phosphorus, therefore, the present study was planned to determine the optimum NP level and irrigation requirements of a new mungbean cultivar NM-54 under irrigated conditions on a sandy loam soil of Thal region.

MATERIALS AND METHODS

Field experiments were conducted at the Agronomic Research Station, Karor, District Layyah, during 1996-99. The experiments were laid out in a split plot design with three replications. The net plot size was 3m x 6m. Mung cultivar NM-54 was used as a test crop. Irrigation regimes were kept in main plots and fertilizer levels in subplots. Irrigation regimes comprised 1,2,3 and 4 irrigations applied at flowering (AI); 30 days after germination (DAG) + flowering (A2); 30 DAG + flowering + pod formation (A3) and 30 DAG + flowering + at pod formation + 10 days after pod formation (A4), respectively. The fertilizer levels were 0-0-0 (Ft), 27-92-0 (F_2) and 54-184-0 (F_3) NPKlha. All phosphorus and half of nitrogen in the form of urea and DAP respectively were applied at sowing, while the remaining half of nitrogen was top-dressed with first irrigation. Seed @ 30 kg/ha was drilled with

14.54%. Among the F_1 hybrids, the cross Qalandri x Allepo-I, however, expressed the maximum average heterosis (17.11%) and hetetobeltiosis (14.54%). Expression of positive average heterosis and heterobeltiosis in all the F_1 hybrids indicated that dominant and overdominant genes were controlling the yield. The present fmdings that non-additive genes were responsible for the yield are in conformity with the results of Khan et al. (1985) and Tiwari et al. (1987). Potence ratio also confirms the overdominant gene action for this trait (Ansari and Lank et al., 1992).

Keeping all the parameters in view, it may be concluded that the heterosis and dominance values were appreciably influenced by the genotype and the direction of the cross. The cross Qalandri x Allepo-I may be singled out as the better hybrid combination since it exhibited high parent heterosis in all the six parameters studied. This hybrid can be successfully exploited for the development of a future cotton variety.

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Table 3. Heterosis (%) values over mid parent (MP), heterobeltiosis (BP) and dominance estimates (D.E) for six quantitative and qualitative traits in *Gossypium hirsutum* L.

Cross	Genetic parameter	Plant height	No. of sympodial branches! plant	Bolls per plant	G.O.T. (%)	Staple length	Yield of seed cotton per plant
TH-1174 x Qalandri	MP BP DE	+ 18.64 + 13.41 + 4.04	+ 10.93 + 5.66 + 2.10	+ 11.25 + 3.10 + 1.42	+ 2.78 + 1.85 :.. 3.03	+ 5.00 + 1.14 + 1.31	+ 9.57 + 6.04 + 2.78
Qalandri x Allepo-I	MP BP DE	+ 1.65 + 6.57 + 1.26	+ 5.31 + 4.16 + 4.84	+ 3.73 + 0.29 + 1.09	+ 3.70 + 2.94 + 5.00	+ 5.19 + 1.75 + 1.53	+ 17.11 + 14.54 + 3.70
TH-1174 x IM-216	MP BP DE	- 2.30 - 7.52 - 0.40	+ 18.36 + 9.43 + 2.25	+ 22.03 + 9.01 + 1.84	+ 2.52 + 1.32 + 2.12	+ 1.46 - 5.14 + 0.21	+ 8.72 + 4.69 + 2.52
TH-3/83 x G 115-7	MP BP DE	+ 34.67 + 12.49 + 1.75	- 12.34 - 14.18 - 4.37	+ 32.41 + 13.86 + 4.97	- 4.93 - 5.32 -11.85	+ 4.35 + 3.17 + 3.78	+ 14.17 + 1.30 - 4.93
Rehmani x Mic Naire	MP BP DE	+ 30.55 + 5.44 + 1.25	+ 15.19 + 14.00 + 14.46	+ 26.90 + 16.37 + 2.97	+ 2.72 + 1.70 + 2.71	+ 4.01 + 3.53 + 8.46	+ 8.13 + 1.14 + 2.72
SLD x TH-3/83	MP BP DE	- 21.39 - 22.17 - 19.33	+ 21.69 + 15.68 + 4.17	+ 27.42 + 12.28 + 2.03	+ 3.43 + 0.88 + 1.36	+ 3.08 + 1.29 + 1.74	+ 5.95 + 5.95 + 3.43
Rehmani x IM-216	MP BP DE	+ 4.62 + 0.06 + 1.01	+ 2.13 - 2.06 + 0.50	+ 21.00 + 15.69 + 4.57	+ 2.33 + 0.43 + 1.23	+ 3.24 + 1.82 + 2.31	+ 4.26 + 1.62 + 2.33
TH-3/83 x Mic Naire	MP BP DE	+ 38.80 + 12.73 + 1.66	+ 1.03 0.00 + 1.00	+ 19.72 + 2.15 + 1.14	+ 4.34 + 2.12 + 2.00	+ 3.42 + 1.41 + 1.92	+ 11.33 + 5.21 + 4.34

presence of transgressive segregants in the population for this trait (Ansari and Larik, 1992).

Staple Length: Parents and F_1 hybrids were highly significantly ($P<0.01$) different in producing fibre length (Table 2). All the F_1 hybrids had more staple length than respective mid parents, whereas seven out of eight hybrids manifested positive heterobeltiosis. Among the F_1 hybrids, Qalandri x Allepo-I expressed maximum average heterosis (5.19%), whereas hybrid Rehmani x Mic Naire manifested the highest (3.53%) heterobeltiosis. Superiority of these hybrids suggested that these could be more useful than other hybrids. The superiority of F_1 hybrids over both parents may be attributed to both dominant and overdominant types of gene action (Ansari and Larik, 1992; Baloch et al., 1993).

Yield of Seed Cotton per Plant: The mean performance of the genotypes (Table 1) illustrated that all the F_1 hybrids produced more yield than their respective parents. Highly significant differences ($P < 0.01$) among genotypes were observed (Table 2), indicating the presence of genetic variability for yield of seed cotton. The average heterosis (Table 3) of F_1 hybrids ranged from 4.26 to 17.11%, whereas heterobeltiosis varied from 1.14 to