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EVALUATION OF HIGH YIELDING AND LOW TOXIN GRASSPEA [*LATHYRUS SATIVUS* (L)] GENOTYPES FOR CULTIVATION IN PAKISTAN

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ABSTRACT

Fifteen improved, low toxin grasspea (*Lathyrus sativus* L.) genotypes received from the International Centre for Agricultural research in the Dry Areas (ICARDA), Aleppo, Syria and a local check were tested for two consecutive winter seasons 2004-05 and 2005-06 in the rainfed conditions of National Agriculture research Centre (NARC), Islamabad. Aim of the study was to select the best genotypes that would give high seed yield with low neurotoxin oxalyl-diamino-propionic acid (ODAP) content. Data on maturity days, plant height, biological yield, grain yield, 100-kernel weight, and harvest index were collected. The genotype Sel 736 significantly outperformed other genotypes for yield and it was followed by Sel 1327, Sel 1322, and Sel 1328. These genotypes are suggested to be tested at the Quaid-e-Awam Agricultural Research Institute (QAARI), Larkana for their general cultivation/yield potential.

Key-words: *Lathyrus sarivus* L., high yield, low toxin, germplasm, screening.

INTRODUCTION

Grasspea/chickling vetch locally called *desi mattar* is an important winter-season annual legume belonging to the family Fabaceae and the tribe Vicieae (Biswas and Biswas, 1997). In Pakistan, it is cultivated mainly in the upper parts of Sindh (Larkana, Shikarpur, and Sukkur districts) on the residual moisture of the rice field. Grasspea seed is broadcast in rice field when water is standing in the area or the soil is very wet. After seed sowing, rice crop is harvested and grasspea is allowed to grow on the same land without additional water. Furthermore, it is also grown along the river banks in Sindh and southern Punjab on the fresh deposits of alluvial soil where moisture conditions are comparatively better than the adjoining up lying areas. It is best adapted to medium to heavy texture soils where the annual rainfall ranges between 300 and 650 mm (Siddique *et al.,* 2006). It is mainly used as green fodder for the livestock but is also used as a food legume for human consumption (Zahid and Khan, 1996). The chemical composition of seed shows high crude protein concentration and low level of cholesterol (Senatore and Basso, 1994).

Despite its potential under rainfed area and high protein for food and feed, it contains a neurotoxin called oxalyl-diamino-propionic acid (ODAP), which is known to cause disease of "*lathyrism"*, hence its cultivation is restricted in particular area where farmers have low choice. The grain, if consumed over a period of more than three months, causes non-remitting and irreversible spastic paraplegia (paralysis of lower limbs) in humans, called lathyrism, for which no cure has been yet discovered (Khawaja, 1996). For solving problem of human lathyrism and making the grasspea an important crop for the marginal areas, we need to introduce zero or low toxin (<0.02 percent ODAP) varieties that are safe for human consumption. ICARDA has developed bold seeded genotypes with zero ODAP and these varieties will not only reduce the risk of *lathyrism* but will also help to refine the economic conditions of the resource poor farmer by improving yield and quality of the hardy crop that needs minimum inputs.

MATERIALS AND METHODS

Fifteen elite grasspea genotypes with low ODAP were received from ICARDA, Aleppo, Syria during 2004. Two field experiments were conducted to evaluate potential differences in yield response of these genotypes along with a local check in the sub-humid, sub-tropical climate of NARC, Islamabad during 2004-05 and 2005-06. Plots measuring 1.2 x 4 m (4.8 m^2) with four rows $plot^{-1}$ were sown manually using single row hand drill on November 18 and November 10 during the winter season 2004-05 and 2005-06, respectively. Seeding was done at 30 cm row spacing at a rate of 200 seeds $plot^{-1}$ corresponding to 10 cm plant interspacing. A randomized complete block design (RCBD) with three replications was used for the experiments. Experiments were conducted on separate but adjacent sites, where cereal and legume crops had been grown for the last many years. Experimental plots were randomized similarly in both the experiments. Soil fertility conditions and plant density were all similar in both years. Sowing was done on residual soil moisture received from the fall rains.

Soil of the experimental area was clay loam, deep, and slightly alkaline with pH 8.0, low in organic matter (0.5 percent) and deficient in N (0.042 percent) and P (5.4 ppm) except for available K (78.5 ppm) (Qamar, 1997). The rainfall for the winter season 2004-05 and 2005-06 is given in Table 1.

Table 1. Monthly rainfall received during the study period 2004-05 and 2005-06.

Month	**Rainfall (mm)**	
	Year 2004-05	**Year 2005-06**
November	23.1	3.94
December	30.1	9.09
January	59.2	53.79
February	184.4	22.90
March	75.4	51.81
April	13.9	20.56
May	20.3	41.26
Total:	**406.4**	**203.35**

Source: Agricultural Meteorological Data Record, Water Resources; Research Institute (WRRI), NARC, Islamabad

At maturity, data on plant height, maturity days, grain yield, biological yield, and 100-kernel weight were recorded. Three plants were randomly sampled from each plot at maturity and the height was measured in cm with the help of meter rod from soil surface to the final growing point and the average was calculated accordingly. Biological yield was determined by harvesting crop manually at maturity from each plot and the harvested above-ground stuff (grain + straw) was weighed in the field just after harvesting of the crop and converted into kg ha^{-1}. Grains were separated from the harvested stuff of each plot and calculated on kg ha^{-1} basis. Hundred grains were randomly separated from the harvested stuff of each plot and weighed in gram for recording 100-kernel weight. Harvest Index (HI) was expressed as percentage of ratio between grain yield and biological yield.

Data were subjected to combined analysis of variance over two years using RCB design with three replications and 16 *Lathyrus* genotypes for different plant characters with the help of computer software 'MSTAT-C' (Bricker, 1991). Fisher's Least Significant Difference (*LSD*) was applied for comparing genotype means. The promising genotypes were identified on the basis of significant differences in grain yield, biological yield, and resistance to diseases/abiotic stresses.

RESULTS AND DISCUSSION

The results of combined analysis of variance across two years showed significant differences among all the genotypes for all the characters under this study (Table 2). The combined ANOVA revealed insignificant interaction between years and genotypes except for 100-kernel weight. Although the year and genotype interaction for 100-kernel weight was significant yet it was not large relative to the average effect of the genotypes. The insignificance and smallness of the interaction effect for all the characters indicated that ranking of the genotypes over the years was stable--so the interaction was ignored (Hoshmand, 1994). Except biological yield, all the other recorded plant characters differed significantly over the years ($p<0.01$). In the year 2004-05, higher rainfall during the study period, gave rise to higher yield structure, which made the year effect differ significantly.

In Table 3, the average of two years showed that the introduced genotypes took 178 to 181 mean days to reach maturity while the local check took only 170 days indicating that the introduced genotypes are comparatively late maturing than that of the local one. The genotype Sel 736 produced the mean tallest plants followed by the genotype Sel 1304, whereas the lowest plant height was observed in the local check. The biological yield and grain yield of genotype Sel 736 were also significantly higher than that of the other genotypes. Karadag *et al.,* (2004) reported that the biological yield and seed yield of 11 grasspea lines ranged 4566 to 6858 and 1029 to 1681 kg ha^{-1}, respectively under the rainfed conditions of semi arid regions of Turkey. The grain yield of 20 grasspea cultivars varied from 320 to 3000 kg ha^{-1} over different environments in Ethiopia (Tadesse, 2003).

Table 2. Combined analysis of variance of randomized complete block design over two years

Source of Variation	*d.f.*[1]	Mean Square					
		MAD[2]	PTHT[3]	Bio YLD[4]	Grain YLD[5]	100 KW[6]	HI[7]
Year	1	412.51**	7245.38**	7179775.09^{ns}	5248155.38*	13.58**	478.11**
Reps within year	4	12.35	283.33	5988399.24	422551.49	0.12	21.76
Genotype	15	38.18**	235.26**	11960926.66**	1160612.97**	33.40**	88.84**
Year x Genotype	15	3.51^{ns}	56.20^{ns}	1360761.89^{ns}	213154.18^{ns}	1.29**	25.30^{ns}
Pooled Error	60	5.72	31.19	832020.60	187797.02	0.35	25.89

[1]Degrees of Freedom' [2]Maturity Days; [3]Plant Height; [4]Biological Yield; [5]Grain Yield; [6]100 Kernel Weight
[7]Harvest Index; ** = significant at 1 % level; *= significant at 5 % level, ^{ns} = non-significant

Table 3. Two years combined mean values for the six characters of grasspea genotypes.

Genotype	Production Traits					
	Maturity Days	Plant Height (cm)	Biological (kg ha^{-1})	Grain Yield (kg ha^{-1})	100-Kernel Weight (g)	Harvest Index (HI)
Sel 736	181^{ab}	79.00^{a}	9133^{a}	2495^{a}	17.620^{a}	27.23^{bcdef}
Sel 1303	180^{abc}	73.67^{abcde}	7291^{b}	1794^{bcd}	8.667^{bcde}	24.51^{efg}
Sel 1321	178^{abc}	67.00^{fg}	6215^{cdef}	2066^{abc}	8.267^{cde}	32.93^{ab}
Sel 1322	180^{abc}	67.33^{efg}	6944^{bcd}	2122^{ab}	8.083^{de}	30.38^{abcde}
Sel 1323	178^{abc}	73.17^{abcdef}	6493^{bcdef}	1688^{bcd}	9.233^{b}	25.57^{efg}
Sel 1325	180^{abc}	74.83^{abcd}	7465^{b}	1746^{bcd}	8.833^{bc}	23.75^{fg}
Sel 1327	180^{abc}	73.83^{abcd}	7256^{bc}	2167^{ab}	8.700^{bcde}	29.26^{abcdef}
Sel 1328	179^{abc}	66.50^{g}	6562^{bcde}	2102^{ab}	8.900^{bc}	31.48^{abcd}
Sel 1329	181^{ab}	70.17^{bcdefg}	5972^{def}	1592^{cd}	8.067^{e}	26.52^{def}
Sel 1330	178^{abc}	71.83^{bcdefg}	6423^{bcdef}	1503^{d}	8.783^{bc}	23.72^{fg}
Sel 1304	181^{ab}	76.33^{ab}	7291^{b}	2003^{abcd}	8.750^{bcd}	27.75^{bcdef}
Sel 1307	178^{abc}	68.50^{defg}	5520^{ef}	1876^{bcd}	8.867^{bc}	33.79^{a}
Sel 1319	180^{abc}	69.67^{cdefg}	6111^{def}	1586^{cd}	8.750^{bcd}	26.32^{def}
Sel 1326	178^{abc}	68.50^{defg}	5486^{f}	1783^{bcd}	8.617^{bcde}	32.81^{abc}
Sel 1332	178^{abc}	75.50^{abc}	6840^{bcd}	1839^{bcd}	8.333^{cde}	27.06^{cdef}
Local	170^{d}	51.50^{h}	2326^{g}	466.7^{e}	6.550^{f}	20.12^{g}
Mean	179	70.46	6457.82	1801.79	9.06	27.70
Std Mean*	0.24	0.57	93.1	44.23	0.06	0.52
LSD (0.05)	2.76	6.45	1053	500.50	0.68	5.88

* = Standard error of the mean.

The apparent greater response in the 100-kernel weight of genotype Sel 736 compared to other genotypes indicated that its seed size is prominently large enough than that of the other genotypes. Tay *et al.*, (2004) reported mean 100-seed weight of 30 g for Luanco-INIA--a new large seed Chilean grasspea cultivar, which can be increased up to 35 g in the favourable environment. So, the 100-kernel weight of genotype Sel 736 is quite reasonable and potential exists to improve it further. Although the genotype SEL 736 performed outstandingly in other characters but its HI percentage was little bit lower than that of the other genotypes suggesting it has relatively moderate physiological efficiency for converting dry matter into final grain yield.

Rao *et al.,* (2005) reported that the higher level of production gives grasspea greater potential as a forage plant in the southern Great Plains. Grasspea can be grown under conditions of water stress, which many other crops cannot withstand and can therefore, successfully be introduced in rangelands for forage purposes (Khawaja, 1996). Being cool-season active plant, it can provide green forage for the livestock during winter when local flora becomes dried. Keeping in view the high biological yield of 9133 kg ha^{-1}, the genotype Sel 736 is suggested to be tested in the rangelands of Pothwar area as a potential forage plant.

A number of fungal, bacterial, nematicidal, and viral diseases have been associated with grasspea crop all over the world but a very little work has been done on the pathological aspect of this crop in Pakistan (Khan *et al.,* 1996). However, no disease was recorded during the two years of the study suggesting that the tested genotypes were resistant to pest attack. Although germplasm of the tested genotypes came from the nursery having low neurotoxin stock but it is suggested to test ODAP content of the high yielding genotypes Sel 736, Sel 1327, Sel 1322, and Sel

1328 before releasing variety from these genotypes for cultivation in Pakistan.

Table 4. Results of the analyses of variance for the individual years using an RCB design with 3 replications and 16 genotypes.

SOV[1]	*d.f.*[2]	Mean Square					
		DMAD[3]	PTHT[4]	YLD[5]	BYLD[6]	100 KW[7]	HI[8]
Year 2004-05							
Replication	2	16.19	403.08	464376.89	9532265.89	0.24	16.08
Genotype	15	15.07**	176.09**	1037090.98**	8438955.86**	16.98**	54.25
Error	30						
Year 2005-06							
Replication	2	8.52	163.58	380726.08	2444532.58	0.00	
Genotype	15	26.62	115.37**	336676.15**	4882732.69**	17.71**	27.45**
Error	30						

[1]Source of Variation; [2]Degrees of Freedom; [3]Days of Maturity; [4]Plant Height; [5]Grain Yield;
[6]Biological (DM) Yield; [7]100-Kernel Weight; [8]Harvest Index; ** = significant at 1 % level.

Conclusion

Since genotype Sel 736 performed outstandingly among all the genotypes and it was followed by the genotypes Sel 1327, Sel 1322, , and Sel 1328, hence these have been selected for further testing at the Quaid-e-Awam Agricultural Research Institute (QAARI), Larkana—a representative experimental site for grasspea testing in the province of Sindh.

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