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Impact of fertilizer levels and intercropping on economic performance of sugarcane and sugar beet under agro ecological conditions of Dera Ismail Khan

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Abstract

To investigate the impact of sugar crop intercropping and different levels of NPK fertilizers, a study was conducted at Agriculture Research Institute, Dera Ismail Khan. Sugarcane verity "HSF-240"and sugar beet verity "Antak" was used in experiment. Six treatments of fertilizers i.e. F_0 (0-0-0), F_1 (100-100-100), F_2 (150-150-150), F_3 (200-200-200), F_4 (250-250-250) and F_5 (300-300-300) NPK kg ha^{-1}. Row spacing between sugarcane and sugar beet was kept 90 cm. The results regarding weight per stripped cane, weight per beet, sugar recovery, sugar yield were significantly influenced by the application of treatments. The maximum and economically feasible cane parameters were recorded at F_4 (250:250:250 NPK kg ha^{-1}). The economic analysis revealed that maximum BCR (5.09) was recorded in F4 (250-250-250 NPK kg ha^{-1}) in sugarcane intercropped with sugar beet showing the superiority of F_4 with intercrop and hence recommended for the farmers, to get maximum return per unit of capital invested.

Key words: Sugarcane, Sugar beet, Intercropping, Fertilizers, yield, economics

Introduction

Sugarcane is an important and high value cash crop of Pakistan. It is significantly important for sugar and sugar related production. The sugar industry plays a vital role in the national economy of a country. Sugarcane accounts for 3.4 percent in GDP of Pakistan. During July-March 2013-2014, sugar export earned foreign exchange of US$ 236.8 million. Sugarcane was sown on an area of 1173 thousand hectares during 2013-2014 against last year's 1129 thousand hectares showing an increase of 3.9 percent. The production of sugarcane for the year 2013-2014 stood at 66.5 million tons, against the target of 65 million tons for 2013-2014 shows 2.3 percent more production against targets and to compare last year's production which was 63.8 million tones, showing an increase of 4.3 percent. The increase in production is due to more area sown, favorable weather conditions as well as improvement in soil fertility (Anonymous, 2014). Sugarcane and sugar beet are two sources for manufacturing sugar in Pakistan. In Pakistan, more than 99% sugar is extracted from sugarcane and only less than 1% from sugar beet. The province of Khyber Pukhtoonkhwa has been enjoying a unique position in the Indo Pak-sub continent, where both sugarcane and sugar beet are grown side by side in the same field, and are compatible with each other. Sugar yield in Pakistan is 50 t ha^{-1} which is very much low than Brazil with the highest yield(Vievra., 2002).Pakistan is the 15th largest producer of sugar in the world, 5thlargest in terms of area under sugarcane cultivation and 60thin yield (Rehman *et al.*, 2010).The reasons for low yield include conventional planting methods, costly inputs, and heavy weed infestation, improper land preparation, less than recommended seed rate, imbalanced fertilizer application, shortage of irrigation water, illiteracy, less support price, lack of coordination between growers and mill owners, natural calamities, delayed harvesting, attack of insect, pests and diseases, poor management of ratoon crop and salinity. Due to increasing population, land holdings are reducing, therefore farmers want maximum return from a limited area using their scare resources, and they want to protect themselves against a possible crop failure. The main objective of intercropping is higher productivity per unit area in addition to stability in production.

The productivity of sugar mainly depends on the use of chemical fertilizers, which results in nutritional balance. Increased prices and shortage of availability of fertilizers in Pakistan put the economic pressure of farmers. The research studies on various aspects of sugarcane and sugar beet has been evaluated as a sole crop under different ecological zones of Pakistan. The present research was conducted to evaluate the performance of sugarcane and sugar beet intercropping with different fertilizer levels, and to evaluate the compatibility of both crops for maximum economic return under the agro ecological conditions of D.I. Khan.

Materials and Methods

To evaluate the effect of intercropping of sugarcane and sugar beet with sole sugar crop an experiment was conducted at Agriculture Research Institute, Dera Ismail Khan. The experiment was laid out in Randomized Complete Block Design (RCBD) with split plot

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arrangement replicated four times. The main plots comprised of sugarcane, sugar beet and their intercropping, while in the sub plots fertilizers levels were studied. The fertilizer levels were F_0 (Control), F_1 (100-100-100), F_2 (150-150-150), F_3 (200-200-200), F_4 (250-250-250), and F_5 (300-300-300) NPK kg ha^{-1}. The sub plot size will be 4.5 m x 5 m (22.5 m^2). All the agronomic practices were kept uniform in all treatments. The sugarcane was planted at R_xR distance 90 cm and then it was irrigated. At a workable condition of soil (20 days after planting sugarcane), the sugar beet was dibbled manually on the ridges, with plant to plant distance of 15 cm. The phosphatic and potash fertilizers were applied once at sowing as basal dose, while nitrogen was applied in three different split doses. The first dose (1/3) was applied at the time of germination completion at the end of February, the second dose (1/3) was applied at the start of cane formation stage, (at the end of March) and the 3rd dose (1/3) was applied after the uprooting of sugar beet in the month of May. The pre emergence weedicide (Dualgold) was applied to control weeds. Earthing up was done in the first week of June. Various parameters of this research were analyzed statistically by following Steel *et al.* (1997).

Results and Discussion

Weight of stripped cane and beet (kg)

The data revealed that weight per stripped cane (kg) was significantly affected by NPK doses but intercropping depicted non-significant response. It is clear from Table 1 that weight per stripped cane ranged from 0.55 to 1.14 kg in fertilizer response, while sole crop (0.96) shows more weight per stripped cane than intercrop (0.90) plant. The highest weight per stripped cane (1.14 kg) was recorded in F4 and F5 treatments in sole crop and F5 in intercrop (1.09 kg) was found statistically at par with those yielding highest in the sole crops. The gain in weight per stripped cane was due to the NPK role in the translocation and synthesis of plant sugar. Our results are in line with the findings of Ayub *et al*. (1999), Nazir *et al*. (1999), Ali and Afghan (2000), Nadeem *et al.* (2011) and Aslam *et al.* (2014). They also reported an increase in sugarcane yield with increasing fertilizer doses.

The data showed significantly different response to NPK doses, but intercropping depicted non- significant response. It is evident from Table 1 that weight per beet ranged from 0.66to 1.81 kg in fertilizer response, while sole crop (1.35) shows more weight per beet than intercrop (1.26) plant. This increase may be due to no inter-specie competition. The highest (1.81 kg) weight per beet was recorded in F5 (300:300:300) with sole crop which was at par with the treatment receiving highest level of fertilizer in the intercrop treatment (1.74 kg). The plots treated with higher NPK doses resulted the higher sugar beet weight $plant^{-1}$. Due to healthy plants which hopefully further resulted in healthy sugar beet roots. This all happened because the soil fertility was greatly improved by the use of higher quantities of fertilizers. So, we found significant increase in response to higher dose of NPK. These results are supported by the work of Wyszynski *et al*. (1999) and Oad *et al*. (2008). They also reported an increase in weight per beet with as increasing fertilizer dose.

Table 1: Weight per stripped cane of autumn sugarcane and weight per beet influenced by different nutrient doses and intercropping (kg)

Treatments	Sugarcane		Sugar beet	
	Sole Crop	Intercrop	Sole Crop	Intercrop
F_0 (Control)	0.63h	0.55h	0.75fg	0.66g
F_1 (100-100-100)	0.84fg	0.78g	1.09de	1.02ef
F_2 (150-150-100)	0.98de	0.90ef	1.21c-e	1.12de
F_3 (200-200-200)	1.05b-d	0.99c-e	1.50a-c	1.36b-d
F_4 (250-250-250)	1.14a	1.08a-c	1.72a	1.63ab
F_5 (300-3000-300)	1.14a	1.09ab	1.81a	1.74a
Means	0.96	0.90	1.35	1.26
LSD	0.09099		0.3249	

Sugar recovery (%)

Sugar recovery (%) was significantly affected by NPK dose but intercropping depicted non- significant response (Table 2). Sugar recovery in sugarcane ranged from 9.36to 9.99 in fertilizer response, while sole crop (9.81 %) shows more sugar recovery percentage in sugarcane than intercrop (9.70 %) plants. The highest sugar recovery of 10.13 % was recorded in F_5 (300:300:300) in sole sugarcane while F_5 in intercrop sugarcane crop (10.07 %) and F_4 with sole crop (10.06 %) were found statistically at par with each other. The increasing trend in sugarcane recovery percent was observed with increase in fertilizer dose. The increment of fertilizer levels have increased nutrient availability to plants and due to complimentary effect of N, P and K, all energy was utilized in increasing quantity of biomass. These results confirmed the findings of Bhoi and Takalkar (2008). They also reported an increase in % sugar recovery in sugarcane with increasing fertilizer dose.

Table 2: Sugar cane recovery (%) of sugarcane and sugar beet as affected by intercropping and different treatments

Treatment	Sugarcane		Sugar beet	
	Sole Crop	Intercrop	Sole Crop	Intercrop
F_0 (Control)	9.40de	9.31e	12.17g	12.09fg
F_1 (100-100-100)	9.63c-e	9.44de	12.73d-e	12.69ef
F_2 (150-150-100)	9.75a-e	9.63 b-e	12.90b-e	12.85c-e
F_3 (200-200-200)	9.95a-c	9.79 a-d	13.16a-c	13.07a-d
F_4 (250-250-250)	10.06ab	9.94 a-c	13.27a	13.24ab
F_5 (300-3000-300)	10.13a	10.07 ab	13.27a	13.21ab
Means	9.81	9.70	12.92	12.90
LSD	0.4662		0.3553	

Mean in the respective category do not differ significantly at 5% level of probability according to LSD test

Sugar recovery (%) in sugar beet crop was significantly affected by NPK application but intercropping gave non-significant results. Sugar recovery in sugar beet ranged from 12.17to 13.27 % in fertilizer response, while sole crop showed 0.96 % more sugar beet recovery than intercrop 12.92 % plant. The highest %sugar recovery (13. 27%)in sugar beet was recorded both in F4 and F5 with beet sole crop and incase of beet intercrop it was recorded 13.21%which was statistically at par with those yielding higher sugar recovery. Our results are in agreement with the findings of Usmanikhel *et al*. (2005), Panhawer *et al*. (2007), Nadeem *et al.* (2011) and Islam *et al.* (2013). They also reported an increase in sugar beet recovery %age with increasing fertilizer dose.

Yield of crops (t ha^{-1})

The data on sugarcane yield revealed significant effect by application of nitrogen, phosphorus and potassium fertilizers but intercropping showed non-significant response (Table 3). Yield of sugarcane was greater in sole crop (11.70t ha^{-1}) than intercrop (10.94t ha^{-1}). The highest cane yield amongst the fertilizer levels was found statistically highest in F_5(300:300:300) having the value of 16.68 t ha^{-1}in sole sugarcane crop, while in intercrop sugarcane yield was 16.33 t ha^{-1}. The F4 with sole crop (15.95 t ha^{-1}) was found statistically at par with F_5 with intercrop. This increase in sugarcane yield might be ascribed to complimentary effect of increased nutrient availability and improved air circulation and light interception which improved photosynthetic efficiency and stripped cane yield. This resulted insignificant increase in response to higher dose of nitrogen, phosphorus and potassium. Our results are in agreement with the findings of Ali *et al.* (2000), Ramesh and Varghese (2000), Ramesh *et al.* (2000), El-Tilib *et al*. (2004) and Khan *et al.* (2005). They also reported an increase in sugarcane yield with increasing fertilizer doses.

Table 3: Sugarcane and sugar beet yield (t ha^{-1}) as affected by intercropping and different fertilizers rate

Treatment	Sugarcane		Sugar beet	
	Sole Crop	Intercrop	Sole Crop	Intercrop
F_0 (Control)	4.34h	3.78h	1.93g	1.62g
F_1 (100-100-100)	8.06g	7.31g	3.53ef	3.29f
F_2 (150-150-100)	10.02e	9.09f	4.70d	4.43de
F_3 (200-200-200)	14.77cd	13.99b	6.71c	6.20c
F_4 (250-250-250)	16.33a	15.50bc	9.02b	8.50b
F_5 (300-3000-300)	16.68a	15.95ab	11.46a	11.05a
Means	11.70	11.94	6.22	5.8
LSD	0.8214		0.9988	

Mean in the respective category do not differ significantly at 5% level of probability according to LSD test

Sugar yield in sugar beet was significantly affected by nitrogen, phosphorus and potassium dose but intercropping depicted non-significant response (Table 3). Amongst the treatment in the sugar beet plots, the highest yield of 11.46 t ha^{-1}was recorded in F_5, which was at par with intercropped plots receiving the maximum dosage of fertilizer. We found significant increase in response to higher doses of nitrogen, phosphorus and potassium. Our results are in agreement with the findings of Bahadar *et al*. (2007). They also reported an increase in beet sugar yield with increasing fertilizer dose.

Benefit cost ratio (ha^{-1})

The calculation of sugarcane net field benefit (NFB) for each treatment is the step in economic analysis of the experimental data (Table 4). The data revealed that sugarcane benefit cost ratio (ha^{-1}) was significantly affected by NPK doses and intercropping. It is clear from Table 4 that benefit cost ratio (ha^{-1}) ranged from 1.57 to 5.09 in fertilizer

response, it revealed that intercrop (3.84) shows more benefit cost ratio (ha^{-1}) than sole crop (3.30) plant. The highest per hectare sugarcane benefit cost ratio (5.09 %) was recorded in F4 (250:250:250) in intercrop sugarcane while F5 in intercrop sugarcane (4.97%) and F4 with sole crop (4.19%) were found statistically at par with each other. It was further noted that higher BCR might be due to the improved air circulation and light interception which improved photosynthetic efficiency. Our results showed significant increase in response to higher dose of NPK. Similar results are reported by Ali *et al.* (2000), Ramesh and Varghese (2000), Ramesh *et al.* (2000), El-Tilib *et al.* (2004), Khan et *al.* (2005). They also observed an increase in sugar cane Benefit cost ratio (ha^{-1}) with an increasing fertilizer dose.

Table 4: Benefit cost ratio (ha^{-1}) of sugarcane and sugar beet as affected by intercropping and fertilizers levels

Treatments	Sugarcane		Sugar beet	
	Sole Crop	Intercrop	Sole Crop	Intercrop
F_0 (Control)	1.57h	1.85g	1.36g	1.85fg
F_1 (100-100-100)	2.77f	2.95ef	2.06f	2.95cd
F_2 (150-150-100)	3.11e	3.44d	2.30ef	3.44c
F_3 (200-200-200)	4.19c	4.73b	2.75de	4.48b
F_4 (250-250-250)	4.19c	5.09a	3.06cd	5.09a
F_5 (300-3000-300)	3.95c	4.97ab	2.91d	4.98ab
Means	3.30	3.84	2.41	3.80
LSD	0.1876	0.5107		

Mean in the respective category do not differ significantly at 5% level of Probability according to LSD test

The data revealed that sugar beet benefit cost ratio was significantly affected by NPK doses and intercropping. It is clear from Table 4that greater benefit cost ratio (ha^{-1}) was found in the intercropped than sole sugar beet crop (2.41). The highest sugar beet benefit cost ratio (ha^{-1}) (5.09%) was recorded in F4 (250:250:250) with intercrop sugar beet, followed by (4.98%)in F5 with sugar beet intercropped and F4 with sole beet crop (3.06%), respectively, and these results were found statistically at par with each other. Our results are in agreement with the findings of Bahadar *et al.* (2007). They also reported an increase in sugar beet benefit cost ratio (ha^{-1}) with increasing fertilizer dose.

References

Ali, F. G., M. A. Iqbal, A.A. Chatha and S. Afghan. 2000. Fertilizer-use efficiency and cane yield under different nitrogen levels and weed management practices in spring-panted sugarcane. *Pakistan Sugar Journal* 15(1):22-26.

Ali, F. G. and S. Afghan. 2000. Effect of fertilizer and seed rate towards stripped-cane yield of spring-planted sugarcane. *Pakistan Sugar Journal* 15(4): 12-16.

Anonymous.2014, Agriculture in Pakistan Economic survey (2013-14). Govt. of Pak. Finance division. Economic Advisory Wing, Islamabad.P.20.

Aslam, M., M. A. Javed and K. B. Malik. 2014. Comparative performance of a promising cane variety SPF-234 in southern Punjab. *Pakistan Sugar Journal* 13(2): 5-10.

Ayub, M., R. Ahmad, A. Tanveer, H. Z. Ahmad and M. S. Sharar.1999. Growth, yield and quality of sugarcane (*Saccharum officinrum* L) as affected by different levels of NPK application. *Pakistan Journal of Biological Sciences* 2(1):80-82.

Bahadar, K., M. Sadiq, M. Subhan A.U. Khan, P. Khan and D. Khan. 2007. Production potential of sugar beet intercropping with sugarcane under various planting geometry system. *Pakistan Sugar Journal*.22 (l): 76-81.

Bhoi. P. G. and B. J. Takalkar. 2008. Present scenario of sugar industry in Maharashtra and it's future strategies. *Cooperative-Sugar* 40(3): 41-48.

El-Tilib, M.A., M.H. Elnasikh and E.A. Elamin. 2004. Phosphorus and potassium fertilization effects on growth attributes and yield of two sugarcane varieties grown on three soil series. *Journal of Plant Nutrition* 27(4): 663-699.

Islam, M.S., M.K. Bejun, M.R. Alam and M.S. Arefin. 2013. Evaluation of some qualitative and quantitative characters of ten sugarcane genotypes under water logging stress conditions. *Pakistan Sugar Journal* 28(01): 10-15.

Khan, I. A., A. Khatri, G. S. Nizamani, M. A. Siddiqui, S. Raza, N.A. Dahar. 2005. Effect of NPK fertilizers on the growth of sugarcane clone AEC86-347 developed at NIA, Tandojam, Pakistan. *Pakistan Journal of Botany* 37(2): 355-360.

Nadeem, M. A., M. A. Sarwar, A. Ghaffar, F. Ahmad and F. Hussain. 2011. Studied on the performance of some sugarcane genotypes at Faisalabad. *Pakistan Sugar Journal* 26(01): 16-21.

Nazir, M.S., A. Gaffar. K. Mahmood, S. Nawaz and M. Aslam. 1999. Morho-quanititative traits of autumn Sugarcane as influenced by seeding density and

nutrient management. *International Journal of Agriculture and Biology* 1(4): 238-240.

Oad, F. C., M. U. Usmanikhail, M. H. Saddique and N. June. 2008. Response of Sugar beet (*Beta vulgaris)* (variety kaweterma) to different fertility levels. *Pakistan Sugar Journal*23 (2): 5-10.

Panhwar, D. B., R. N. Panhwar, N. Gugar, M. A. Mammon, A. H. Mari and I. B. Bhatti. 2007. Response of sugar beet to different rates of soil applied nitrogen with constant dose of phosphorus. *Pakistan Sugar Journal* 22 (04): 20-23.

Rehman, A., A. Qayyum and T. Afzal. 2010. Efficiency dynamics of sugar industry of Pakistan. 25th Annual General Meeting and Conference of the Pakistan Society of Development Economist, March 16-18, 2010, organized by Pakistan Institute of Development Economics, Islamabad, Pakistan.

Ramesh, V. and S. Varghese. 2000. Effect of fertilizer levels of N, P and K on the yield and juice quality of Sugarcane. *Indian Sugars* 50(5): 301-302.

Ramesh, P. 2000. Effect of drought on nutrient utilization, yield and quality of Sugarcane (*Saccharum officinarum*) varieties. *Indian Journal of Agronomy* 45(2): 401-406.

Steel, R.G.D. and J.H. Torrie and D. Dicky. 1997. Principles and procedures of statistics. McGraw Hill Book Co., Inc., New York.

Usmanikhel, M.U., G.S. Tunio, H.I. Majeedano, S. Shahani and L.M. Baloch. 2005. Effect of fertility levels on growth, beet root and quality of Sugar beet. *Pakistan Sugar Journal* 10(5): 13-16.

Vievra. 2002. Genetic instability of sugarcane plants derived from meristem cultures. *Genetic Molecular Biology 25*(1): 91-96.

Wyszynski, Z., Z. M. Kaalinowska and B. Broniecka, 1999.The effect of growth period, growth rate and application rate and application method of nitrogen fertilizers on yield and technological quality of sugar beet. Part 11. Technological yield of sucrose and root quality. Roczniki Naukrolniczych. Seria A, *Produkcja Roslinna* 114 (1/2): 101-112.