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WHEAT GROWTH, YIELD AND NUTRIENT ALLOCATION IN RELATION TO MECHANICAL AND CHEMICAL WEED MANAGEMENT PRACTICES

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ABSTRACT

The study was conducted to envisage wheat growth, yield and nutrient allocation under mechanical and chemical weed management practices. The experiment was laid out in a quadruplicated randomized complete block design. The experiment compared two weed management practices, i.e. mechanical and chemical for their impact on wheat growth, yield and nutrient allocation, while furnishing a control for both the weed management practices. In control plots (T1), no any type of weeding practice was performed during the entire growing season. While in other plots, either hand-weeding was performed for the full season (T2) or an effective commercial post-emergence broad leaf herbicide was applied at 1.25L ha^{-1} when the crop gained four week's maturity. The data for plant height, number of tillers $plant^{-1}$ and grain and straw yields were recorded. Phosphorus and potassium contents were determined in grain and straw samples. Compared to hand-weeding, plants grown in control plots were significantly shorter, produced significantly lower grain and straw yield and generally had low phosphorus and potassium allocated to their straw and grain. The two practices of weed management were found at par with each other for plant height, grain and straw yield, and the potassium contents in wheat grain and straw. Interestingly, the phosphorus contents in grain and straw were better in plots receiving chemical weed management practice as against hand-weeded plots. The study endorses the benefits of weed management practices, irrespective of their mode, in improving wheat growth, enhancing wheat yield and allocating nutrients to the grain and straw of wheat efficiently.The chemical weed control method was found superior in enhancing wheat tillers and mobilizing more phosphorus to wheat crop for its efficient allocation to wheat grain and straw.

Keywords: Herbicide, nitrogen, phosphorus, straw and grain yield, weed competition.

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INTRODUCTION

In Pakistan, wheat (*Triticum aestivum* L.)covers an area of over eight million hectares, bringing the country amongst world's top 10 wheat producing countries (Khan *et al*., 2006). Nonetheless, the average wheat yield in the country is not at par with other countries of the world. Its neighbor China is still getting more than two-fold wheat yield (GOP, 2009). There is a cascade of reasons for this low yield however; imbalanced fertilization in view of nutrient deficiencies of Pakistani soils appeared to be the major culprit (Nisar *et al*., 1996). While plant nutritionists in Pakistan are trying their best to come up with the state-of-the-art fertilization techniques for wheat (Khan *et al.*, 2006; Maitlo *et al.,* 2006; Vishandas *et al*., 2006), a major hindrance in the success of any plant nutrition program is the weed infestation, claiming over 50% of the crop yield (Nisar *et al*., 1996). Weed-crop competition for essential nutrients and the resultant decrease in yield is now well established (Bond and Burston, 1996; Nisar *et al*., 1996; Iqbal and Wright, 1997; Das and Yaduraju, 1999; Reddy *et al*., 2003). Hence, it is highly desirable to study various weed management practices for their impact on plant nutrient allocation and the growth and yield of wheat. There are several weed management practices, however, mechanical and chemical weed management are often practiced (Oerke and Dehne, 2004). A number of studies illustrated the benefits of mechanical weeding (Choubey *et al*., 1998) and the application of post-emergence herbicides (Nicholls and Altierri, 1997; Powels, *et al*., 1997) as efficient weed management practices. However, little is known about the efficacy of these two weed management practices in improving wheat growth and yield by influencing the phosphorus and potassium allocation to wheat grains and straw. This study was designed to evaluate wheat growth, yield and nutrient allocation under the influence of mechanical and chemical weed management practices.

MATERIALS AND METHODS

This study was conducted at the Latif Experimental Farm of Sindh Agriculture University, Tandojam that is located at the geographical coordinates of 25° 26' 0" N, 68° 32' 0" E. The soil analysis of 0-15 cm and 15-30 cm depths suggest that it was clay textured with moderately alkaline in reaction, non-saline, non-sodic and calcareous in nature and adequate in potassium content. The organic matter and phosphorus contents of the soil were deficient to affect wheat production (Table 1). The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications, arranged in 12 plots of 2.5m x 8m size. The experiment compared two weed management practices, i.e. mechanical and chemical for their impact on wheat growth, yield and nutrient allocation, while furnishing a control for both the weed

management practices. In control plots (T1), no weeding practice was performed during entire growing season of wheat. While in other plots, either hand-weeding was performed for the full season (T2) or an effective commercial post-emergence broad leaf herbicide was applied at 1.25L ha^{-1} when the crop gained four week's maturity. Seedbed was properly prepared through following standard techniques. Composite soil samples were taken from two depths, i.e. 0–15 cm and 15–30 cm before fertilizer application and wheat sowing. The soil samples were air-dried, passed through 2 mm sieve and analyzed for texture, eletrical conductivity, pH, organic matter, Olsen phosphorus and NH_4OAc-extractable potassium by following standard methods as described by Ryan *et al.* (2001). Pure quality seed of wheat *cv.* Mehran-89 was obtained from Wheat Section, Agricultural Research Institute, Tandojam. The hydroprimed seed was drilled at 125 kg ha^{-1} with a single coulter hand drill. A blanket dose of 170 kg N and 85 kg P ha^{-1} was given to wheat crop through urea (46% N) and di-ammonium phosphate, DAP, (18% N and 46% P_2O_5). Half nitrogen and all of the phosphorus were applied at the time of seedbed preparation by broadcasting. The remaining half of the nitrogen was applied at the time of first irrigation. The recommended dose (1.25 L ha^{-1}) of the post-emergence herbicide was thoroughly mixed with water in a separate container to get the uniform driftand applied after first irrigation, i.e. when the crop was at third leaf stage. The crop received a total of five irrigations up to maturity.

At maturity (145 days after sowing), five pre-selected and properly tagged random plants were harvested at ground level and sun-dried to record growth parameters of wheat. Plant height was recorded with measuring tap. Ears of each plant were separated from the straw for threshing by hand. The grains and straw yields were first recorded on per plant basis, and then after considering the plant population per plot, converted to yield per hectare. Phosphorus and potassium contents were determined from oven-dried (68 ^{0}C for 48 hours) and ground samples (Wiley Mill) of grain and straw by following the Wet-Ashing method as suggested by Ali and Narryan (2009). The statistical analysis was performed by using the MSTAT-C. Mean separation was done through utilizing the least significant difference (LSD) test at alpha 0.05.

RESULTS AND DISCUSSION

Soil of the experimental site

The soil analysis data (Table 1) of 0-15 cm and 15-30 cm depths indicate that the soil of the experimental area was clay in texture, non-saline, non-sodic, moderately alkaline in reaction and poor in organic matter content. The soil samples were low in phosphorous content at both depths. The extractable potassium (K) in soil was high at both depths.

The high soil K was possibly due to the presence of micaceous minerals bearing K (Rahmatullah and Mengel, 2000; Rajpar *et al*., 2006).

Species and density of natural weed flora

The major natural weed flora species grown in experimental plots were Jhill (*Chenopodium album L.)*, Naro (*Convolvulus arvensis)*, Sinjh (*Melilotus alba)*, Jungli Palak (*Rumex dentatus L.)*, Nili buti (*Anagallis arvensis)*, Kabah (*Cyperus rotundus)*, Dumbi Gah (*Phalaris minor)*, Jangli Joie (*Avena fatua)*, Chabbar (*Cynodon dactylon)* etc. It is also evident from the reports of Khoso (1992) that these are the most common broad leaved, grasses and sedge weed species of wheat fields in Sindh. The average weed density in the weedy plots was 417 weeds per m^2.

Effect of hand-weeding and herbicide application on growth and yield of wheat

The effect of weed management methods (Table 2) on plant height, tillers $plant^{-1}$, and grain and straw per hecatre yield remained significant ($p<0.05$). The difference between hand-weeding and herbicide treatments was smaller and non-significant. Taller plants with more tillers and higher grain and straw yields were obtained from both hand-weeding and herbicide treated plots (T2 and T3). Analysis of phosphorus and potassium (Table 2) in grains and straw samples indicated that the influence of handweeding on phosphorus and potassium accumulation was significant ($p<0.05$). The grain and straw samples obtained from control plots receiving no weed management practice, exhibited significantly lower phosphorus and potassium than those grown in hand-weeding and herbicide treated plots. The results obtained from the study showed that weeds adversely affected all recorded growth and yield variables. Compared to plots receiving no weed management practice, plants grown in hand-weeding and herbicide treated plots were 12 and 14% taller, produced 22 and 27% more tillers and gave 23 and 27% higher straw yield and produced 47 and 52% more grain yield, respectively. These significant improvements were possibly due to soil aeration, availability of essential nutrients, high moisture (Turk and Tawaha, 2003; Gurnah, 1985) content and exposure of wheat plants to sunlight in weed free plots. Tanveer *et al.* (2001) reported a significant effect of hand-weeding and herbicide application on wheat growth and yield. The better performance of plants grown in these two treatments can also be attributed to higher contents of P and K in straw and grains. As compared to the weedy plots, the grain samples obtained from the plants grown in herbicide and handweeding treatments plots showed 24 and 43% more P and 67 and 73% more K, respectively. Similarly, compared to control plots receiving no weed management practice, the plants grown in herbicide and handweeding plots had 33% and 49%

more phosphorus and 43 and 60% more potassium in straw, respectively. The two practices of weed management were found at par with each other for plant height, grain and straw yield of wheat, and potassium contents of wheat grain and straw. Interestingly, phosphorus contents of grain and straw were better in plots receiving chemical weed management practice as against hand-weeded plots.

Table1.Soil physical and chemical properties determined before sowing and fertilization.

Soil properties		Soil depth	
		0-15 cm	*15-30 cm*
Texture	Sand %	28.00	30.50
	Silt %	30.00	28.50
	Clay %	42.00	41.00
	Textural class	Clay	Clay
EC_e (dS m^{-1})		0.31	0.33
pH (1:5 in H_2O)		7.91	8.20
Organic matter content (%)		0.85	0.65
Available P (mg Kg^{-1})		3.86	2.40
Exchangeable K (mg kg^{-1})		188.50	140.30

Table 2. Effect of weed management practices on yield and nutrient allocation to wheat grain and straw.

Variables	Weeding Treatments			LSD (alpha 0.05)
	Control (T_1)	Hand-Weeding(T_2)	Herbicide Application(T_3)	
Plant height (cm) at maturity	102.7b	115.1a	117.4a	9.618**
Tillers (plant^{-1})	67.0b	82.0b	85.0a	5.602***
Grain yield (kg ha^{-1})	2680.7b	3950.3a	4063.3a	479.31***
Straw yield (kg ha^{-1})	3950.0b	4849.7a	5020.0a	597.12**
P % in grain	0.302b	0.375ab	0.432a	0.0785**
P % in straw	0.101b	0.134ab	0.150a	0.0434*
K % in grain	2.006b	3.344a	3.468a	0.2489***
K % in straw	0.426b	0.608a	0.682a	0.17820***

Means followed by same letter in a column and row do not differ statistically at alpha 0.05.

*Slightly significant, **Significant, ***Highly significant

CONCLUSION

The study endorsed the benefits of weed management practices, irrespective of their mode, in improving wheat growth, enhancing wheat yield and allocating nutrients to the grain and straw of wheat efficiently. The chemical weed control method was found superior in enhancing

wheat tillers and mobilizing more phosphorus to wheat crop for its efficient allocation to wheat grain and straw.

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