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The Role of Soil Variability in Weed Research

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ABSTRACT

An experiment was conducted on farmers' field in a wheat-fallow-wheat cropping pattern under rainfed conditions on three soil families to study the role of soil variability in weed research. It was found that the yield potential of the soil depends upon the initial fertility status of the soil and on its other physio-chemical properties. The yield potential of Guliana soil family was greatest while Missa soil family had greater potential than Balkassar. Weeds were a serious problem in Guliana soil family, moderate in Missa soil family while minor in Balkassar soil family. The kinds of weeds in three soil families were almost the same but their occurrence order was altogether different. The weed population density was greatest in Guliana soil family while least on Balkassar soil family.

INTRODUCTION

Wheat is an important crop of rainfed areas of Pakistan. It is often infested with numerous types of weeds which reduce its yield. The reduction in yield is due to competition for nutrients, water, light and space. It is dependent upon the composition and density of weed population which in turn is dependent, in addition to other factors, upon type of soil. Crammer (1967) observed that weeds decreased yield from 10 to 15 percent of the wheat crop. Nizami and Shafiq (1987) in the experiment on two soil families reported 7 to 35 percent decrease in yield of wheat at various fertilizer levels.

The density of weeds that occupy certain areas varies according to season (kharif and rabi) of the year, type of crops, climatic conditions, soil type, fertilizer level and its kind, method of crop management, etc. Nitrogen appears to be the most critical for most crop-weed competition. Blackman and Templemen (1983) observed that in a period of normal rainfall, competition between crops and weeds is primarily for nitrogen.

Soil moisture is one of the most critical factors in crop production. Its importance increases under dry land agriculture. According to Nizami and Shafiq (1987), although the fertility level of Guliana soil was much greater than of Missa soil, still the weed population and hence the decrease in yield of wheat crop was greate in Missa soil family than in Guliana soil family because of higher plant available moisture in the former during the season.

Water Use Efficiency (WUE) is another factor causing decrease in crop production. Dillman (1931) found *Portulaca oleracea* having WUE of 3.94 where as that of corn 2.77. The other important soil factors that can affect the weed seedling growth and development are available nutirent level, organic matter content and pH.

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To increase crop production, weed control is considered to be an important tool. Lot of work has been done to control the weeds (chemically and mechanically) and thier effect on yield improvements. Little research work so far has been done based on different soil families which are the basic unit of soil management. The present study was undertaken to find out the role of soil variability in weed research.

MATERIALS AND METHODS

A field study was conducted on farmer's field in three soil families and the benchmark soils of these were Guliana, Missa and Balkassar located in Daultala-Jatli area of Pothwar Plateau. The detailed description of these soils is given in appendix. The fields were fallow before experimentation and the cropping pattern was wheat-fallow-wheat. The seedbed preparation was done at proper moisture levels. The soils were sampled for analytical analysis. All the fertilizer was applied at recommended rate by broadcast method. Wheat (L-73) was sown and seed rate was 100 kg/ha. Two levels of weeds (weeded and unweeded) were maintained under RCB design. The weeding was done by manual labour.

The weed flora composition was counted during the whole growing season and average is given in table 2. At maturity the crop was harvested and yield was recorded. The percent decrease in yield was worked out.

RESULTS AND DISCUSSION

Comparison of the yield of wheat crop in weeded and unweeded plots and the increase in yield due to weeding is presented in table 1. It is evident that the percentage of increase in yield due to eradication of weeds is greatest (38.4%) on Guliana soil family. The production potential of this family on weedy (3.12 t/ha) and non-weedy (4.32 t/ha) plots (Table 1) and the weed plant population (118/m^2) (Table 2) is highest among three soil families. This is becasue the fertility status of Guliana soil is the highest among three, as is evident by the available NO_3, PO_4, K and organic matter content of the soil (Table 3). There is also no problem of phosphorus fixation ($CaCO_3$ less than 1%). Secondly, the plant available water to a depth of 150cm is highest (150mm) among three soil families (Sandhu, Dawson and Nizami, 1987). Therefore, the soil moisture stress is least and the plant (wheat crops and weeds) survive for longer period under drought.

In Missa soil family the increase in yield ranges form 20.7 to 25.2 percent. The average increase in yield is 23.2 percent (Table 1). The prodcution potential on weedy (2.67 t/ha) and non-weedy (3.29 t/ha) is higher than Balkassar soil family but lower than Guliana soil family. The weed plant population is 80/m^2 (Table 2). Missa soil has lesser available NO_3, PO_4, K, and organic matter content than Guliana soil family (Table 3). It has a serious phosphorus fixation problem ($CaCO_3$ 17.6 to 18.6%). The plant available moisture is about 120 mm upto a depth of 150 cm. Therefore, during droughty period it has in some days moisture stress both for the wheat crop and weeds. The presence of a semi cemented calcic horizon within a depth of 30 cm also restricts root penetration both of the

Table 1. Wheat yield (t/ha) and percent increase due to weeding in three soil families.

Name of soil	Site I			Site II			Site III			Average		
	Weeded	Unweeded	Percent increase in yield	Weeded	Unweeded	Percent increase in yield	Weeded	Unweeded	Percent increase in yield	Weeded	Unweeded	Percent increase in yield
Guliana soil family	4.28	3.10	38.3	4.48	3.17	41.6	4.20	3.10	35.3	4.32a	3.12b	38.4
Missa soil family	3.49	2.82	23.5	3.35	2.67	25.2	3.03	2.51	20.7	3.29a	2.67b	23.2
Balkassar soil family	2.47	2.24	10.2	2.26	2.06	9.6	2.66	2.3	11.4	2.46a	2.23b	10.4

Mean followed by common letters are not significantly different within the row.

Table 2. Kinds of weeds and their occurrence in three soil families.

Botanical Name	Local name	Guliana soil family		Missa soil family		Balkassar soil family	
		Weed density (No/m^2)	Percentage of total	Weed density (No/m^2)	Percentage of total	Weed density (No/m^2)	Percentage of total
Convolvulus arvensis	Lali	67	58	13	16	7	19
Vicia faba	Rewari	21	16	45	56	2	6
Fumaria indica	Papara	13	11	9	11	9	25
Tribulus terrestris	Bakhra	9	8	7	9	4	11
Chenopodium album	Bathu	5	4	2	3	1	3
Carthamus oxyacantha	Pohli	3	3	4	5	13	36
	Total	118	100	80	100	36	100

Table 3. Properties of diffeent soil families

Soil family	Clay	Silt	Sand	pH	$CaCO_3$	Organic carbon	Even B.D. g/cm^3	Water content 1/3 bar %	Water content 15 bar %	mg/kg (PPM) NO_3	mg/kg (PPM) PO_4	mg/kg (PPM) K
Guliana soil												
0-12cm	19.3	73.9	6.8	7.9	0.9	0.55	1.49	20.5	8.6	10.9	6.3	125
12-50cm	20.3	73.8	5.9	7.7	0.2	0.56	1.49	21.8	8.9	10.5	4.2	94
Missa soil												
0-11cm	11.6	75.8	12.6	8.1	17.0	0.48	1.31	17.6	7.0	10.2	4.7	86
11-50cm	12.8	78.1	9.1	8.2	20.0	0.29	1.48	18.6	7.4	7.85	1.5	41
Balkassar soil												
0-11cm	12.2	18.1	69.7	8.0	2.0	0.39	1.51	14.6	8.7	7.4	2.9	56
11-50cm	14.9	19.5	65.6	8.2	3.0	0.22	1.52	13.5	8.8	3.6	1.1	35

wheat and weeds plant because of higher soil strength (Nizami, 1975). It also creates hinderance in the availability of nutrients and moisture below this horizon to the plant.

The Balkassar soil is developed in a residum of sandstone and hence has moderately coarse texture which over lie semi-consolidated sandstone within a depth of 100 to 130 cm (Appendix). The plant available moisture is only 54 mm (Sandhu, Dawson and Nizami, 1987). The available nutrient status is least among the three soil families (Table 3). Therefore, the production potential of the soil with weeds (2.23 t/ha) and with eradication of weeds (2.46 t/ha) is least among these three soil families. The weed population is only $36/m^2$ (Table 2) due to which the percentage of increase in yield due to eradication of weeds is least (10.4%). It ranges from 9.6 to 11.4 percent.

The kinds of weeds (Table 2) on three soil families whithin the same climatic zone is almost the same. However, the order of occurrence is altogether different among these three. This clearly shows that the difference is due to different physio-chemical properties of the soil. This is in agreement with Shahida Khalid, 1988 and Nizami and Shafiq, 1987 who reported that the uptake of various weed species is different. Therefore, their occurrence on soils having different degrees of available nutrients should be different. The moisture stress also played part in reducing the yield specially in soil having low plant available moisture. The plant available water is in the decreasing order on Guliana, Missa and Balkassar soil family and the weeds population and production potential of wheat is also on the similar pattern.

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APPENDIX

Detailed Profile Description of Benchmark soils

1. Guliana Soil

(Fine-silty, mixed, hyperthermic udic Haplustalfs)

Guliana soil occurs in broad level loose plains. It is well drained with moderately slow permeability.

Profile description

AP 0-12cm Silt loam, noncalcareous, pH 7.9, bulk density 1.49, organic carbon 0.55.

BT 12-83cm Silty clay loam, moderate medium subangular blocky structure, noncalcareous, pH 7.8, bulk density 1.38, organic carbon 0.56.

BTC83-150cm Silt laom, weak coarse subangular blocky structure, slightly calcareous, pH7.8, bulk density 1.40, organic carbon 0.33.

2. Missa soil

(Coarse-silty, mixed, hyperthermic, gently sloping typic ustochrepts).

Missa soil occurs in dissected loose plains. It is well drained and has moderately slow permeability.

Profile description

AP 0-11 cm Silt loam, strongly calcareous, few lime nodule, pH 8.1, bulk density 1.31, organic carbon 0.48.

BTK11-60 cm Silt loam, weak, coarse, subangular, blocky, strongly calcareous, few lime nodule, pH 8.2, bulk density 1.48, organic carbon 0.38.

BC60-96 cm Silt loam, weak coarse prismatic structure, strongly calcareous, few lime nodule, pH 8.4, bulk density 1.45, organic carbon 0.26.

C196-150cm Silt loam, massive, very few lime nodule, pH 8.4, bulk density 1.59.

3. Balkassar Soil

(Coarse-loamy, mixed, hyperthermic udic Haplustalfs)

Balkassar Soil occur on ridge and through upland from sandstone. It is well drained and has moderately rapid permeability.

Profile description

AP 0-11 cm Sandy loam, slightly calcareous, loose, pH 8.0, bulk density 1.51, organic carbon 0.4.

B1 11-37 cm Sandy loam, moderately calcareous, weak structure pH 8.2, bulk density, 1.51 organic carbon 0.22.

BTK37-70 cm Sandy loam, moderately calcareous, weak structure pH 8.2, bulk density, 1.52, organic carbon 0.22.

BCTK70-100cm Sandy loams, moderately calcareous, pH 8.4, bulk density 1.54, organic carbon 0.2.

C1 100-150 cm Loamy sand, moderately calcareous, single grain, pH 8.4, bulk density 1.5, organic carbon 0.1.