With regard to phosphatase activity the fertilizer treatment M_2 receiving 100 per cent recommended dose of fertilizer recorded significantly the highest value of 24.95 µg P nitrophenol g^{-1} hr^{-1} (Table 2). Among the humic acid treatments S6 (25.26 µg P nitro phenol g^{-1} hr^{-1}) recorded the highest value. The treatment combination M2S5 recorded the highest value of 25.80 µg P nitrophenol g^{-1} hr^{-1}. The result obtained in the present study was in line with Kiss *et al.* (1975) who stated that the mineral fertilizers containing P compounds increased the soil phosphatase activity. Soil application of humic acid significantly influenced the phosphatase activity, which might be attributed to the increased microbial population in the soil. The addition of humic acid along with mineral fertilizers showed a marked increase in the phosphatase activity of the soil. This might be due to the increased supply of essential nutrients which in turn might have enhanced the microbial activity and hence the phosphatase activity in soil.

References

Kiss, S., Dracan - Bularda, M., and Radulesan, D. (1975). Biological significance of enzyme accumulated in soil. *Adv. Agron.* **27**: 25-87.

Kudrina, E.S. (1951). The effect of humic acids on certain groups of soil micro-organisms. Trudy Pochv. Inst. Dokuchaeva. 38.

Mathur, S.P. and Paul, E.A. (1966). A microbial approach to the problem of soil humic acid structure. *Nature*, **212**: 646-647.

(Received: December 2002; Revised: July 2003)

Madras Agric. J. 90 (10-12) : 738-741 October-December 2003

Research Notes

Genetic determination of grain yield and quality traits through its components in *Triticum duram*

S.V. SAI PRASAD
Indian Agricultural Research Institute - Regional Station, Indore - 452 001, Madhya Pradesh

Genetic determination of yield and its components helps the breeder in identifying traits, which are responsible for achieving high yield. The magnitude along with the direction of association between two traits determines the usefulness of the correlation and helps in simultaneous improvement for these traits. The present investigation was taken to work out the inter-relationships of grain yield and quality traits through its components by correlation and path-coefficient analysis. Sixty genotypes of durum wheat were evaluated in the *rabi* 2001 at the farm of Indian Agricultural Research Institute - Regional Station, Indore. The genotypes constituted a collection of genetic stocks, released varieties and advance lines. The genotypes were sown in a RBD with a row to row and plant to plant spacing of 30 and 10 cm, respectively. Observations were recorded on five randomly selected plants for each entry from each replication for various traits including quality traits like protein content, sedimentation value and β carotene.

Analysis of variance revealed significant differences for all the characters under study. The range of variations was quite high for most of the characters (Table 1). High heritability along with high genetic advance was noticed for the characters like plant height, grains per spike, sedimentation value and β-carotene. Therefore, these traits would be effective in selecting genotypes possessing high grain yield. Grain yield per plant showed low heritability along with low genetic advance, which reveal that it was influenced more by the environment. Phenotypic coefficient of correlation was recorded high for the characters like productive tillers, grain weight per spike, grain yield per plant, sedimentation value and β-carotene, indicating influence of environment was considerable for these traits.

able 1. Estimates of parameters of genetic variability for various characters

Characters	Mean	Range		GCV%	PCV%	Herita-bility	GA% as of mean
		Min.	Max.				
Days to flowering	75.7	64.0	94.0	7.9	8.1	0.95*	15.8
Plant height (cm)	100.0	46.3	130.5	18.1	18.8	0.93*	36.1
Productive tillers	8.74	6.0	11.8	11.8	19.0	0.38	15.1
Spikelets/Spike	20.5	16.4	23.1	6.0	6.8	0.76	10.7
Grains per spike	57.8	31.8	78.5	16.3	17.6	0.85*	30.9
Grain weight/spike (g)	2.7	1.2	3.8	18.7	21.1	0.79	34.2
1000 grain weight (g)	43.7	27.3	54.8	10.6	12.3	0.74	18.8
Hectolitre weight (g)	78.2	73.5	82.5	3.4	3.7	0.84	6.4
Grain yield/plant (g)	19.6	10.2	25.6	14.0	23.9	0.34	16.8
Protein percentage (%)	14.2	12.3	17.6	8.3	8.7	0.91*	16.2
Sedimentation value (ml)	27.6	16.0	45.0	25.6	25.8	0.98*	52.5
β-carotene (ppm)	5.2	2.3	8.9	28.9	29.2	0.97*	58.8

The correlation coefficients (Table 2) evealed that grain yield had significant positive ssociation with productive tillers per plant (0.60), rain weight / spike (0.58), grains / spike 0.46), 1000 grain weight (0.43), spikelets / pike (0.30) and hectoliterweight (0.25), whereas, t was significant negative association with days o flowering (-0.18), plant height (-0.20) and rotein content (-0.36). Therefore, selection would e effective if early and dwarf types are identified or improving the grain yield. Hectolitre weight 0.50), sedimentation value (0.42) and β-carotene 0.55) had shown significant positive correlation vith grains/spike. In addition to these traits, 000 grain weight had expressed significant ositive association (0.56) with grain weight spike. Grain yield was influenced by grains/ pike and grain weight /spike, and at the same ime, these traits influence the quality traits, o due weightage must be given for the above raits during selection to develop high yielding ypes with good quality characteristics. Similar bservations were reported by Jaglan *et al.* 1997) and Uddin *et al.* (1997).

Quality traits like hectoliter weight, edimentation value and β-carotene along with ield contributing traits like grains per spike nd grain weight / spike were associated positively among themselves in a significant way, so hectoliter weight and grains/spike can be used as a criterion for improving the sedimentation value and β-carotene content, for developing dual purpose durum lines (Jaglan *et al.* (1997) and Mondal *et al.* (1997)). Protein content is negatively associated with grain yield, 1000 grain weight, hectoliter weight and sedimentation value, so a precautionary approach should be formulated on a compromised manner to improve these traits along with protein content, simultaneously.

Path coefficient analysis (Table 3) revealed that the maximum amount of positive direct effect was exerted on grain yield by productive tillers / plant (0.39) followed by 1000 grain weight (0.29) and grains / spike (0.27). These results agree with the findings of Mondal *et al.* (1997) and Khan *et al.* (1999). Indirect effects are mostly negligible, thus, it is easier to select for the component traits. Grain weight / spike has a relatively larger positive association (0.58) on grain yield, while, its direct effect was negligible. The indirect influence of grain weight / spike via grains / spike (0.23) and 1000 grain weight (0.16) was positive and relatively larger in magnitude. Hence, grain weight / spike could be considered as an important component of grain yield and it could be utilized as one of the selection parameters.

Based on correlation and path analysis, it was observed that biomass yield, productive tillers/plant, grains per spike and grain weight / spike, 1000 grain weight and hectoliter weight

Table 2. Correlation co-efficients between various yield contributing traits

Character	Days to flowering	Plant height (cm)	Productive tillers	Spikelets /spike	Grains /spike	Grain weight/ spike (g)	1000 grain wt. (g)	Hectolitre wt. (g)	Grain yield/ plant (g)	Protein (%)	Sedimentation value (ml)
Plant height (cm)	-0.19										
Productive tillers	-0.19	NS									
Spikelets/spike	0.32	-0.32	NS								
Grains per spike	NS	-0.3	NS	0.51							
Grain weight/spike (g)	NS	-0.50	NS	0.60	0.84						
1000 grain weight (g)	-0.48	NS	NS	NS	NS	0.56					
Hectolitre weight (g)	NS	-0.46	-0.20	0.25	0.50	0.52	0.29				
Grain yield/plant (g)	-0.18	-0.20	0.60	0.30	0.46	0.58	0.43	0.25			
Protein %	0.22	0.56	NS	-0.22	-0.69	-0.61	-0.31	-0.53	-0.36		
Sedimentation value (ml)	NS	-0.19	NS	NS	0.42	0.23	NS	0.28	NS	-0.34	
β-carotene (ppm)	NS	-0.50	NS	0.25	0.55	0.34	NS	0.42	NS	-0.48	0.40

Table 3. Path co-efficients analysis showing direct and indirect effects of characters contributing to grain yield

Character	Days to flowering	Plant height (cm)	Productive tillers	Spikelets/ spike	Grains per spike	Grain weight/ spike (g)	1000 grain wt. (g)	Hectolitre weight (g)	Protein (%)	Correlation with grain yield
Days to flowering	-0.11	0.03	-0.01	-0.02	0.01	-0.01	-0.14	-0.01	-0.01	-0.18
Plant height (cm)	0.02	-0.17	-0.01	0.02	-0.14	-0.02	0.04	-0.01	-0.01	-0.20
Productive tillers	0.01	0.01	0.39	-0.01	-0.03	-0.01	-0.03	-0.01	-0.01	0.60
Spikelets/spike	-0.03	0.05	-0.02	-0.05	0.16	0.04	0.01	0.01	0.01	0.30
Grains per spike	-0.01	0.09	-0.05	-0.03	0.27	0.05	0.04	0.01	0.01	0.46
Grain weight/spike (g)	0.01	0.05	-0.06	-0.03	0.23	0.07	0.16	0.01	0.01	0.58
1000 grain weight (g)	0.05	-0.02	-0.04	-0.01	0.04	0.04	0.29	0.01	0.01	0.43
Hectolitre weight (g)	0.01	0.08	-0.08	-0.01	0.04	0.14	0.08	0.03	0.01	0.25
Protein %	-0.02	-0.10	0.03	0.01	-0.17	-0.04	-0.09	-0.01	-0.01	-0.36

Residual = 0.08

can be used as important selection traits in order of merit to improve yield, quality and productivity of durum wheat under high input conditions.

References

Jaglan, R.S., Tandon, J.P. and Singh, M. (1997). Correlation studies in tall versus dwarf population of bread wheat. *Indian J. Agric. Res.* **31**: 19-22.

Khan, H.A., Shaik-Mohammad and Mohammad, S. (1999). Character association and path coefficient analysis of grain yield and yield components in wheat. *Crop Research,* **17**: 229-233.

Mondal, A.S., Chaudhary, S. and Ghosal, K.K. (1997). Genotypic and phenotypic variability in wheat. *Environment and Ecology,* 9: 926-928.

Uddin, M.J., Biswanath, M., Chawdhary, M.A.Z. and Mitra, B. (1997). Genetic parameters, correlation, path coefficient analysis and selection indices in wheat. *Bangladesh J. Scientific and Industrial Research,* **32**: 523-528.

(Received: December 2002; Revised: September 2003)

Madras Agric. J. 90 (10-12) : 741-743 October-December 2003

Research Notes

Determination of physiological maturity of seeds in amaranthus cv. CO 5

C. MENAKA AND P. BALAMURUGAN
Department of Seed Science and Tech., Tamil Nadu Agrl. University, Coimbatore - 641 003, Tamil Nadu

Amaranthus (*Amaranthus* spp.) is very nutritive and highly stable crop for kitchen garden and commercial cultivation Rapid growth and quick rejuvenation after each harvesting with high nutritive value are its important features. It is one of the cheapest leafy vegetables in tropical and sub tropical parts and it is very valuable source for combating under nutrition and mal-nutrition in India. Since the crop is regenerated through seeds, tracing its physiological maturity to harvest the crop with quality seeds assumes greater importance.

From the bulk crop of Amaranthus cv. CO 5 raised during *Kharif* 1999, the inflorescence were individually tagged. The inflorescence were collected at five days interval upto 30 days after anthesis. The inflorescence harvested at different stages were designated as S_1, S_2, S_3, S_4, S_5 and S_6 representing 5th, 10th, 15th, 20th, 25th and 30th days after anthesis, respectively. Observations on seed colour, moisture content, fresh weight, dry weight, germination (ISTA, 1999), root length, shoot length, dry matter production, vigour index were recorded. The vigour index value was calculated using the following formula (Abdul-Baki and Anderson, 1973).

VI= Germination (%) x Drymatter production (mg)

The colour of the developing seeds was white at 5th day after anthesis and changed to shiny dark black at 25th day after anthesis which indicates the physiological maturity of the seeds (Table 1). Higher moisture content of 52.0% was recorded on 15th day after anthesis and it was decreased to reach 28.0 per cent at 25th DAA (Days after anthesis) and further decrease was noticed at later stages. Per cent moisture of seed /kernels was originally used with the promise that the maturation process consisted of essentially water loss which is dependent upon atmospheric dry conditions (Appleman, 1923). It was reported that increasing moisture of harvested seeds, seedling vigour and viability were reduced. In a similar study, seeds harvested at 30% moisture had higher germination, vigour and yield than seeds harvested at lower or higher moisture. The moisture content is varied at physiological maturity in different crops like corn 25-35% (Carter and Poneleit, 1973) and barley 42-48% (Pinthus, 1963).

The fresh weight of seeds was also high at 25th DAA which is an important factor that