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Performance of Different *Basmati* Cultivars and Nitrogen Scheduling on Growth Parameters in North Western India

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ABSTRACT

An experiment was conducted at the Rice Research Station, CCSHAU, Karnal, to study the effects of nitrogen fertilizer with different basmati rice (Oryza sativa L.) cultivars on growth parameters, yield attributes and yield. The observation were recorded on dry matter accumulation (DMA), leaf area index (LAI), growth rate (CGR), leaf area duration (LAD) at 40, 60, 80 DAS and maturity. The relationship between grain yield with growth indexes measured by correlation coefficient (r) and regression coefficients (R^2). Results of growth analysis indicated that, nitrogen increasing rates and number of split application caused the increment of DMA, LAI, LAD, CGR and AGR. HB 2 and PB 1121 showed higher growth indices rather than PB 1 and PB 1509. Results indicated that cultivar and nitrogen fertilizer significantly effected on dry matter accumulation, LAI, LAD, AGR and CGR. Cultivars differed significantly in respect to dry matter accumulation at all the stages. Basmati cultivar HB-2 recorded maximum dry weight per meter^{-2} but statistically alike with PB-1121 which was significantly higher than PB-1 and PB-1509 at maturity. Maximum LAI was recorded at 80 DAS with cultivar HB-2 followed by PB-1121, PB-1 and PB-1509. At 80 DAS, PB-1121 showed maximum LAD (120.7 & 121.2) which was statistically alike with HB-2 (121.7 & 124.7) and statistically higher than PB-1 (110.7 & 111.9) and PB-1509 (107.2 & 109.5) during 2014 & 2015. At 40 and 60 DAS, there was no significant difference in AGR among all cultivars. AGR increased with advancement of crop growth period up to 80 DAS and thereafter decreased at maturity among all the cultivars. At maturity, maximum AGR was recorded with cultivar PB-1509 (1.25 & 1.30 g day^{-1}) which was significantly higher than rest of cultivars while lowest AGR was recorded with PB-1 (0.94 & 0.96 g day^{-1}). Cultivar HB-2 recorded maximum CGR (23.69 & 24.11 g m^{-2} day^{-1}) which was statistically alike with PB-1121 (20.36 & 23.18 g m^{-2} day^{-1}) and significantly higher than PB-1 (19.70 & 19.69 g m^{-2} day^{-1}) and PB-1509 (16.00 & 17.03 g m^{-2} day^{-1}) at 80 DAS during successive years of study. Dry matter accumulation, LAI, LAD, AGR and CGR increased with increased in nitrogen application up to 110 kg N ha^{-1}. Four split timings results in higher growth parameters than three split.

Key words: *Dry matter accumulation, Direct seeded rice, Nitrogen application, leaf area index, crop growth rate*

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INTRODUCTION

Rice (*Oryza sativa* L.) is a most important staple food of about half of the world population. More than 75% of the world's rice is consumed by people in Asian countries and thus the rice is of great importance for food security in Asia. In India, it is grown on an area of 44 m ha with total production of 105 mt, and productivity of 2390 kg ha^{-1}[14]. Traditionally, rice is sown in puddled soils by transplanting 25 - 45 days old seedlings from wet nurseries of rice. Though this approach has been a long-term practiced, it has problems of poor water management, scarcity of irrigation water supply and drainage facilities inefficiency in input management, and costly labor during the peak transplanting time and inadequate post-harvest practices are drawbacks of transplanting Esfahani *et al*[4]. Direct seeded rice (DSR) is a substitute of rice transplanting method which requires only two man hours to sow the same area Fageria and Baligar[5]. DSR concept entails the use nutrient responsive cultivars with best nitrogen application timings. But there is not much information regarding new hybrids and evolved cultivars under dry or wet direct seeding condition of basmati rice. Keeping this in view the present investigation was undertaken to evaluate the effect of cultivars and nitrogen scheduling.

MATERIALS AND METHODS

A field experiment was conducted at CCS Haryana Agricultural University, Regional Research Station, Karnal during *kharif* season of 2014 and 2015. The soil of the experimental field was clay loam in texture, slightly alkaline in reaction, low in available nitrogen, and medium in phosphorus and potassium. The treatments included four varieties of *basmati* rice, viz. PB-1121, PB-1509, PB-1 and HB-2 and six N levels, viz. N @ 90, 100, 110 kg/ha applied as 3-splits (at 0, 15, 50 days after sowing (DAS) or 4-splits (0, 20, 40, 60 DAS). The experiment was laid out in split-plot design with cultivars in main plots and nitrogen levels in sub-plots with three replications. Full dose of phosphorus (30 kg ha^{-1}) and zinc sulphate (25 kg ha^{-1}) were applied at the time of sowing. 11.5 k N available from diammonium phosphate (used as source of P) was taken as basal dose and the remaining N was applied in equal splits. Recommendations of the state University were adopted for raising the crop. Twenty kg seed per hectare was used for sowing. The seeds were soaked in water along with carbendazim (1g/L water solution per kg seed) for 24 hours and then water was completely drained. The soaked seeds were sown in the evening by using seed drill on 10 June, 2014 and 24 June 2015, keeping row spacing of 20 cm and depth of 2-3 cm. Pre-emergence herbicide pendimethalin 1.0 kg/ha was applied just after sowing (JAS) in a spray volume of 500 L water and bispyribac sodium 25 g ha^{-1} at 20 DAS as spray in a spray volume of 300 L water. Manual weeding was also done at 40 DAS to avoid any infestation of weeds in the crop. For control of stem borer, cartap hydrochloride 4% G @ 7.5 kg ha^{-1} was applied as broadcast in soil at 50 DAS. At 50% panicle emergence, tricyclazole 50% was applied @ 120 g ha^{-1} for management of blast disease. Data on yield attributes and yield were recorded at harvest of the crop. Harvesting was done on 1 November 2014 and 14 November 2015.

RESULTS AND DISCUSSION

Dry matter accumulation

The data pertaining to dry matter accumulation by crop at different growth stages are presented in Table 1. The dry matter accumulation increased with advancement in crop age in all the varieties.

Maximum increase in dry matter was recorded between 60 DAS to 80 DAS followed by 80 DAS to maturity. Cultivars differed significantly in respect to dry matter accumulation at all the stages. *Basmati* cultivar HB-2 recorded maximum dry weight (1100.2 & 1121.2 g m^{-2}) but statistically alike with PB-1121 (1090.7 & 1101.2 g m^{-2}) which was significantly higher than PB-1 (1001.1 & 1010.6 g m^{-2}) and PB-1509 (931.9 & 950.0 g m^{-2}) at maturity during 2014 and 2015, respectively. Varietal differences in growth parameters of various *basmati* rice cultivars were also recorded by Mannan *et al*[9]., and Paliwal *et al*[12].

Table 1: Effect of nitrogen levels and time of application on dry weight (g m^{-2}) of different cultivars of *basmati* rice at different growth stages

Treatment	Plant dry weight (g m^{-2})							
	40 DAS		60 DAS		80 DAS		At maturity	
Cultivars	2014	2015	2014	2015	2014	2015	2014	2015
PB-1121	178.5	181.3	327.13	330.8	734.3	794.4	1090.7	1101.2
PB-1509	160.2	163.2	292.8	299.6	612.9	640.2	931.9	950.0
PB-1	160.3	167.2	304.5	312.6	698.5	706.4	1001.1	1010.6
HB-2	191.8	196.1	325.3	332.2	799.2	814.4	1100.2	1121.2
SEm ±	13.7	10.6	10.4	10.7	7.1	6.0	5.7	12.0
CD at 5%	NS	NS	NS	NS	24.3	19.5	19.5	40.4
Nitrogen levels (kg ha^{-1}) and number of splits								
90-3 splits	159.7	162.0	264.4	268.4	646.6	657.9	878.1	880.3
90-4 splits	148.5	148.6	215.4	290.2	664.0	680.5	945.8	938.4
100-3 splits	177.4	178.9	299.6	305.1	702.5	727.8	995.2	1003.5
100-4 splits	162.1	169.0	324.3	331.1	724.2	757.3	1066.5	1080.9
110-3 splits	205.1	213.0	340.5	348.3	744.1	785.3	1119.3	1148.8
110-4 splits	183.4	190.1	360.3	369.7	786.1	823.7	1180.8	1222.6
SEm ±	3.6	3.8	3.5	3.2	5.5	7.1	6.8	6.2
CD at 5%	10.2	10.9	10.0	9.0	15.7	19.2	19.4	17.8

At all growth stages, increasing N levels and increasing number of splits produced significantly higher plant dry weight (Table 1). Higher dry weight m^{-2} at all crop growth stages was recorded with four splits than three splits at same level of N application. At maturity, maximum dry matter (1180.8 & 1222.6 g m^{-2}) was recorded at 110 kg N ha^{-1} with four splits (0, 20, 40 and 60 DAS) which was significantly higher than rest of treatments. Minimum dry weight was recorded under 90 kg N ha^{-1} (878.1 & 880.3 g m^{-2}) with three splits (0, 15 and 50 DAS). There was increase in dry weight at maturity with increase in N doses from 90 (878.1-945.8 g m^{-2}) to 100 (995.2-1080.9 g m^{-2}) and 110 kg ha^{-1} (1119.3-1222.6 g m^{-2}) in succession at maturity. Similarly, plants dry weight m^{-2} was increased with increase in number of split from three (878.1-1148.8 g m^{-2}) to four (938.4-1222.6 g m^{-2}) at same level of nitrogen. In general, the plant dry weight was slightly higher during 2015 than 2014. Maximum plant height, number of tillers, dry matter accumulation was recorded at 110 kg N ha^{-1} with four numbers of split. Similar trends have been reported by Ehsanullah *et al*[3]., Awan *et al*[1]., and Kaushal *et al*[7]. Table 6 showed positive correlation occurred between grain yield and dry matter accumulation dry matter accumulation (r=0.94). These facts were further elaborated by regression lines drawn between grain yield and growth parameters as well as yield attributes (Fig. 1) with following equations:

Grain yield = 0.023 dry weight accumulation + 21.41 (r^2=0.89),

Leaf area index

The data presented in Table 2 show that LAI increased with the advancement in crop age up to 80 DAS. Among the cultivars, PB-1 produced maximum LAI (3.44 & 3.63) at 40

DAS; however, it was statistically at par with rest of *basmati* cultivars. At 60 DAS, cultivar PB-1121 produced maximum LAI (6.03 & 6.33) which was statistically at par with HB-2 (5.68 & 5.90) but significantly higher than PB-1 (5.17 & 5.20) and PB-1509 (4.83 & 5.13) in both the years of study. At 80 days, maximum LAI was recorded with cultivar HB-2 (6.40 & 6.20); however, the differences were non-significant.

Similarly, nitrogen levels and number of splits also influenced LAI among all the cultivars (Table 2). Higher dose of 110 kg N ha^{-1} with three splits (0, 15 and 50 DAS) recorded significantly higher LAI (4.65 & 4.81) than rest of the treatments under study at 40 DAS. However, at 80 DAS, application of 110 kg N ha^{-1} with four splits recorded significantly higher LAI (6.84 & 6.67) than rest of the treatments. Minimum LAI (5.22 & 5.39) was recorded under 90 kg N ha^{-1} with three splits during 2014 and 2015 respectively. There was maximum increase in LAI at 80 DAS from 90 (5.22-5.57) to 100 (5.90-6.26) to 110 kg N ha^{-1}(6.40-6.84) in succession. Similarly, LAI increased with increase in number of splits from three (5.22-6.60) to four (5.56-6.84) at same level of nitrogen. Interactional effects between LAI of *basmati* cultivars and nitrogen scheduling were not significant. LAI can be attributed to the positive effect of nitrogen on leaf development, tillering and increase in leaves photosynthetic activity durability Fageria and Baligar[5] and Fageria[6]. Positive correlation occurred between grain yield and leaf area index (Table 6), LAI (r=0.92), These facts were further elaborated by regression lines drawn between grain yield and growth parameters as well as yield attributes (Fig. 2) with following equations:

Grain yield = 5.267 LAI + 14.84 (r^2=0.84)

Table 2: Effect of nitrogen levels and time of application on LAI of different cultivars *basmati* rice at different growth stages

Treatment	40 DAS		60DAS		80 DAS	
Cultivars	2014	2015	2014	2015	2014	2015
PB-1121	3.13	3.60	6.03	6.33	6.19	6.10
PB-1509	3.26	3.12	4.83	5.13	5.89	5.80
PB-1	3.44	3.63	5.17	5.20	5.89	6.00
HB-2	3.38	3.41	5.68	5.90	6.40	6.20
SEm ±	0.27	0.26	0.13	0.13	0.23	0.20
CD at 5%	NS	NS	0.46	0.46	NS	NS
Nitrogen levels (kg ha^{-1}) and number of splits						
90-3 splits	2.55	2.57	4.63	4.83	5.22	5.39
90-4 splits	2.21	2.40	5.06	5.30	5.56	5.57
100-3 splits	3.40	3.55	5.36	5.56	6.01	5.90
100-4 splits	3.00	3.15	5.67	5.90	6.26	6.24
110-3 splits	4.65	4.81	5.85	6.01	6.60	6.40
110-4 splits	3.92	4.15	6.07	6.30	6.84	6.67
SEm ±	0.12	0.11	0.09	0.10	0.16	0.08
CD at 5%	0.36	0.33	0.25	0.30	0.48	0.23

Leaf area duration

Table 3: Effect of nitrogen levels and time of application on LAD of different cultivars *basmati* rice at different growth stages

Treatment Cultivars	40 DAS		60DAS		80 DAS	
	2014	2015	2014	2015	2014	2015
PB-1121	67.2	72.0	91.7	99.3	121.7	124.7
PB-1509	65.3	62.4	81.0	82.5	107.2	109.5
PB-1	68.9	72.8	86.3	88.2	110.7	111.9
HB-2	66.6	68.2	90.1	95.9	120.7	121.2
SEm ±	5.5	5.4	1.4	1.5	2.6	2.3
CD at 5%	NS	NS	4.0	4.2	8.9	8.1
Nitrogen levels(kg ha^{-1}) and number of splits						
90-3 splits	51.2	51.5	72.1	74.2	98.7	102.4
90-4 splits	44.6	48.2	72.9	76.7	106.1	109.6
100-3 splits	68.1	71.2	87.7	91.3	113.7	114.8
100-4 splits	60.1	63.3	86.8	90.4	119.2	121.1
110-3 splits	92.8	95.9	104.2	107.7	123.7	123.7
110-4 splits	78.6	83.2	100.2	104.3	129.0	129.5
SEm ±	2.5	2.3	1.5	1.5	1.6	0.9
CD at 5%	7.2	6.6	4.2	4.2	4.6	2.6

Among the cultivars, there were no significant affect recorded at 40 DAS. However, highest LAD recorded with PB-1 and lowest with PB-1509 (Table 3). At 60 DAS, maximum LAD was recorded PB-1121 which was statistically alike with HB-2 and statically higher than PB-1 and PB-1509. Maximum LAD recorded at 80 DAS with PB-1121 (120.7 & 121.2) which was statistically alike with HB-2 (120.7 & 121.2) and statistically higher than PB-1 (110.7 & 111.9) and PB-1509 (107.2 & 109.5) during 2014 & 2015. Similarly, N levels and number of splits also influenced LAD at different intervals of crop growth. LAD recorded with 40 and 60 DAS were maximum recorded with three split than four split at same level of nitrogen dose. Application at 110 kg N ha^{-1} with three splits (0, 15 and 50 DAS) recorded significantly highest LAD than all other treatments at 40 DAS. LAD recorded at 60 DAS (104.2 & 107.7) was maximum at 110 kg N ha^{-1} with three split (0, 15, 50 DAS) than rest of treatments during both the years of study. At 80 DAS maximum LAD (129.0 & 129.5) recorded with 110 kg N ha^{-1} at four split and minimum (98.7 & 102.4) LAD at 90 kg N ha^{-1} with three split. There was maximum increase in LAD at 80 DAS with increase in N from 90 kg (98.7-109.6) to 100 kg (113.7-121.1) to 110 kg ha^{-1} (123.7 129.5) in succession. Similarly, LAD increased with increase in number of splits from three (98.7-123.7) to four (106.1-129.5) at same level of nitrogen at 80 DAS. Interactional effects LAD *basmati* cultivars and nitrogen scheduling on LAD were not significant. Sadeghi and Bohrani[13] reported that low nitrogen leads to lower vegetative growth and low light use efficiency and as a result reduces in leaf area extension decreased LAD. Maximum LAD in each treatment was obtained about 65 days after sowing. Data in Table 6 also showed positive correlation occurred between grain yield and leaf area duration LAD (r=0.96). These facts were further elaborated by regression lines drawn between grain yield and growth parameters as well as yield attributes (Fig. 3) with following equations:

Grain yield = 0.274 LAD + 13.80 (r^2=0.93),

Absolute growth rate

At 40 and 60 DAS, there was no significant difference in AGR among all cultivars (Table 4). AGR increased with advancement of crop growth period up to 80 DAS and thereafter decreased at maturity among all the cultivars. At maturity, maximum AGR was recorded with cultivar PB-1509 (1.25 & 1.30 g day^{-1}) which was significantly higher than rest of cultivars while lowest AGR was recorded with PB-1 (0.94 & 0.96 g day^{-1}) during 2014 and 2015, respectively.

The AGR increased with increase in N levels and number of splits at different growth stages of *basmati* cultivars except at 40 DAS (Table 4). Maximum AGR recorded at 60 and 80 DAS with four split than the three split application at same level of nitrogen. At maturity, AGR was significantly higher at 110 kg N ha^{-1} with four split (1.30 & 1.35 g day^{-1}) than rest of treatments and minimum AGR recorded at 90 kg N ha^{-1} with 3 splits (0.78 & 0.76 g day^{-1}) during 2014 and 2015, respectively. There was maximum increase in AGR at maturity with increase in N from 90 kg (0.76-0.94g day^{-1}) to 100 kg (0.96-1.13g day^{-1}) to 110 kg ha^{-1}(1.23-1.35g day^{-1}) in succession. Similarly, AGR increased with increase in number of splits from three (0.76-1.24g day^{-1}) to four (0.89-1.35 g day^{-1}) at the same level of nitrogen during 2014 and 2015. These results are in conformity with those of Manzoor *et al*[10]. Khanpara *et al*[8]., reported increase in dry matter accumulation, AGR and CGR with increase in fertilizer levels up to 125% of recommended dose.

Table 4: Effect of nitrogen levels and time of application on AGR (g day^{-1}) of different cultivars of *basmati* rice at different growth stages

Treatment Cultivars	Absolute growth rate (g day^{-1})							
	40 DAS		60DAS		80 DAS		At maturity	
	2014	2015	2014	2015	2014	2015	2014	2015
PB-1121	0.89	0.90	1.48	1.49	4.07	4.63	1.11	0.97
PB-1509	0.80	0.81	1.32	1.37	3.20	3.40	1.25	1.30
PB-1	0.83	0.83	1.44	1.45	3.94	3.94	0.94	0.96
HB-2	0.95	0.98	1.33	1.36	4.74	4.82	0.94	0.97
SEm ±	0.06	0.05	0.21	0.19	0.13	0.11	0.04	0.04
CD at 5%	NS	NS	NS	NS	0.44	0.41	0.13	0.15
Nitrogen levels (kg ha^{-1}) and number of splits								
90-3 splits	0.79	0.80	1.04	1.06	3.82	3.89	0.78	0.76
90-4 splits	0.74	0.74	1.37	1.41	3.78	3.90	0.94	0.89
100-3 splits	0.88	0.89	1.22	1.26	4.03	4.22	0.98	0.96
100-4 splits	0.81	0.84	1.62	1.62	4.00	4.26	1.13	1.11
110-3 splits	1.02	1.06	1.35	1.40	4.03	4.37	1.24	1.23
110-4 splits	0.91	0.95	1.77	1.80	4.25	4.54	1.30	1.35
SEm ±	0.02	0.02	0.05	0.04	0.05	0.07	0.03	0.03
CD at 5%	0.05	0.05	0.10	0.13	0.17	0.20	0.13	0.09

Crop growth rate

The data on crop growth rate (CGR) given in Table 5 indicate that there was slow increase in CGR between 0-40 DAS which was maximum increased up to 80 DAS and then declined towards maturity. Crop growth rate at 40 and 60 DAS was found statistically alike among all the cultivars. However, *basmati* cultivar PB-1121 recorded maximum CGR at 40 DAS (4.46 & 4.53 g m^{-2} day^{-1}) and at 60 DAS (7.43 & 7.47 g m^{-2} day^{-1}); while it was lowest in PB-1509 at 40 DAS (4.00 & 4.08 g m^{-2} day^{-1}) and at 60 DAS (6.63 & 6.82 g m^{-2} day^{-1}) during both years of study. At 80 DAS cultivar HB-2 recorded maximum CGR (23.69 & 24.11 g m^{-2} day^{-1}) which was statistically alike with PB-1121 (20.36 & 23.18 g m^{-2} day^{-1}) and significantly higher than PB-1 (19.70 & 19.69 g m^{-2} day^{-1}) and PB-1509 (16.00 & 17.03 g m^{-2} day^{-1}) at 80 DAS during successive years of study. Among all the cultivars, maximum CGR at maturity was recorded in PB-1509 (6.25 & 6.45g m^{-2} day^{-1}) and minimum was recorded in PB-1 (4.73 &4.82 g m^{-2} day^{-1}) during 2014 and 2015, respectively.

Table 5: Effect of nitrogen levels and time of application on CGR (g m^{-2} day^{-1}) of different cultivars of *basmati* rice at different growth stages

Treatment Cultivars	Crop growth rate (g m^{-2} day^{-1})							
	40 DAS		60DAS		80 DAS		At maturity	
	2014	2015	2014	2015	2014	2015	2014	2015
PB-1121	4.46	4.53	7.43	7.47	20.36	23.18	5.57	4.87
PB-1509	4.00	4.08	6.63	6.82	16.00	17.03	6.25	6.45
PB-1	4.01	4.18	7.21	7.26	19.70	19.69	4.73	4.82
HB-2	4.18	4.79	6.67	6.80	23.69	24.11	4.70	4.86
SEm ±	0.26	0.34	1.08	0.96	0.64	0.59	0.20	0.23
CD at 5%	NS	NS	NS	NS	2.21	2.05	0.68	0.78
Nitrogen levels (kg ha^{-1}) and number of splits								
90-3 splits	3.99	4.00	5.23	5.32	19.11	19.47	3.90	3.85
90-4 splits	3.71	3.70	6.84	7.08	18.93	19.51	4.70	4.45
100-3 splits	4.43	4.50	6.11	6.30	20.14	21.13	4.89	4.77
100-4 splits	4.05	4.20	8.11	8.10	19.99	21.31	5.67	5.54
110-3 splits	5.13	5.30	6.77	6.76	20.17	21.88	6.20	6.17
110-4 splits	4.54	4.70	8.84	8.98	21.28	22.69	6.50	6.74
SEm ±	0.08	0.09	0.24	0.24	0.29	0.36	0.15	0.16
CD at 5%	0.25	0.30	0.70	0.70	0.85	1.02	0.42	0.44

CGR increased with increase in N dose and number of splits (Table 5). Maximum CGR was recorded at 80 DAS than all other growth stages. Maximum CGR (21.28 & 22.69 g m^{-2} day^{-1}) recorded at 110 kg N ha^{-1} with four splits (0, 20, 40 and 60 DAS) and minimum CGR (18.93 & 19.51 g m^{-2} day^{-1}) was recorded at 90 kg N ha^{-1} with four splits. There was increase in CGR at maturity with increase in N from 90 kg (19.11-19.51 g m^{-2} day^{-1}) to 100 kg (20.14-21.31 g m^{-2} day^{-1}) to 110 kg ha^{-1} (20.17-22.69) g m^{-2} day^{-1}) in succession. Similarly, CGR increased with increase in number of splits from three (19.11-21.88 g m^{-2} day^{-1}) to four (18.93-22.69 g m^{-2} day^{-1}) at the same level of nitrogen during both the years. Maximum CGR at maturity was recorded under 110 kg N ha^{-1} with four splits (6.50 & 6.74g m^{-2} day^{-1}) and minimum was recorded under 90 kg N ha^{-1} with three splits (3.90 & 3.85 g m^{-2} day^{-1}). Marschner[11], also reported that CGR was increased up to flowering stage after that it decreased. Dasilva and Stutte[2], and Timothy and Joe[15] also reported that nitrogen played due to the having a role in production and translocation of cytokinin from the root to the shoots increases cell division rate and the growth of rice. Positive correlation occurred between grain yield and crop growth rate (Table 6), CGR (r=0.70). These facts were further elaborated by regression lines drawn between grain yield and growth parameters as well as yield attributes (Fig. 4) with following equations:

Grain yield = 4.384 CGR + 27.76 (r^2=0.59),

Table 6: Correlation coefficient between grain yield with growth and yield parameters

Parameters	Grain yield
Grain yield	1.00
Dry matter accumulation at maturity	0.94
Leaf area index at 80 DAS	0.92
Leaf area duration at 80 DAS	0.96
Crop growth rate at maturity	0.70

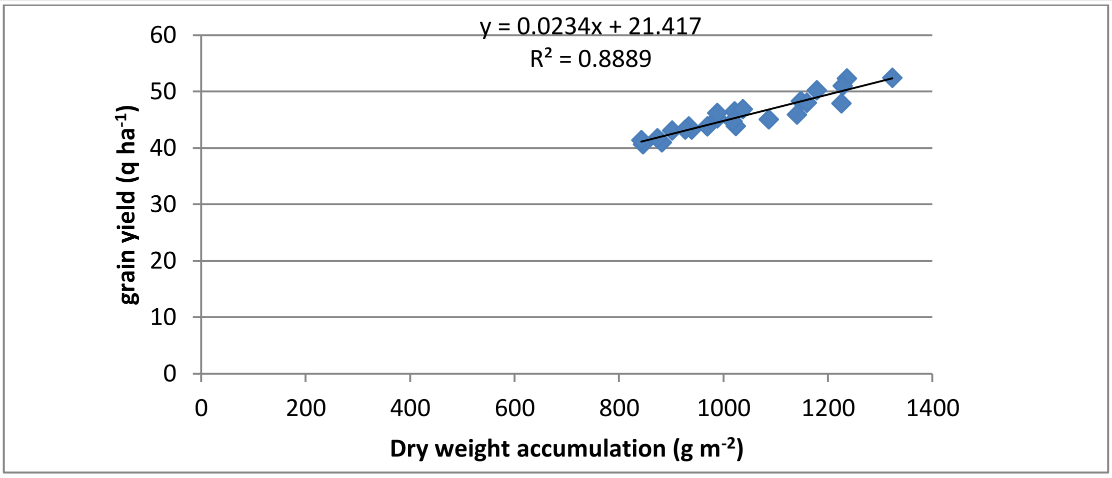

Fig. 1: Regression lines showing relation between grain yield (q ha-1) with dry weight accumulation (g m-) at maturity

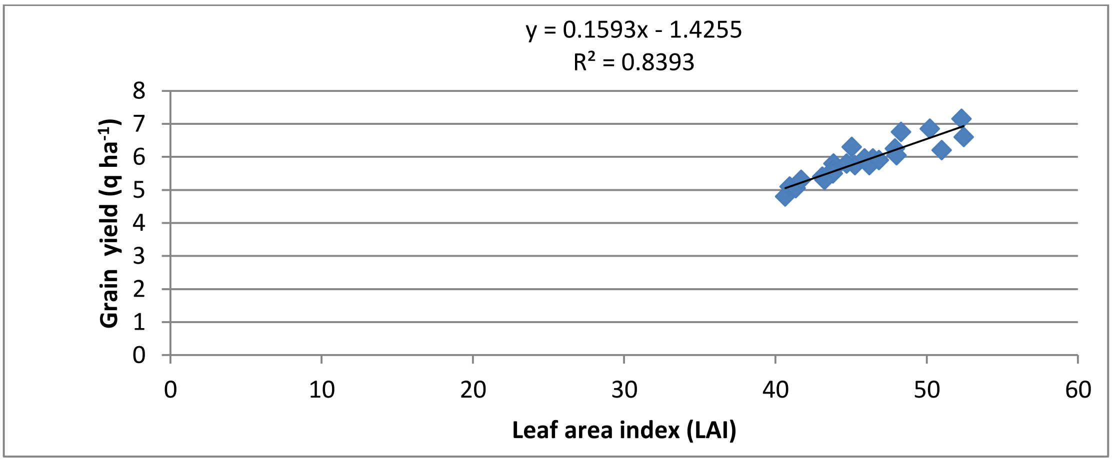

Fig. 2: Regression lines showing relation between grain yield (q ha-1) with leaf area index at 80 DAS

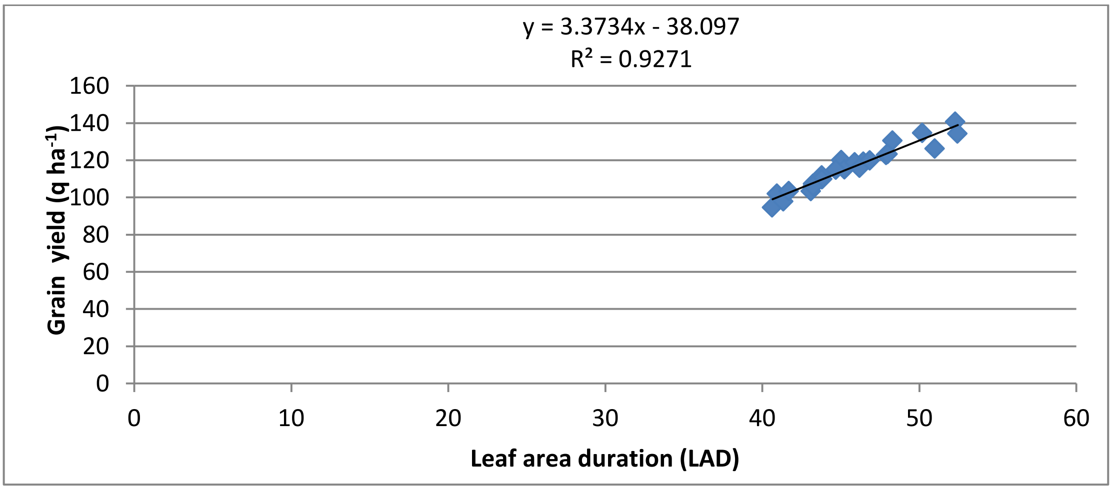

Fig. 3: Regression lines showing relation between grain yield (q ha-1) with LAD at 80 DAS

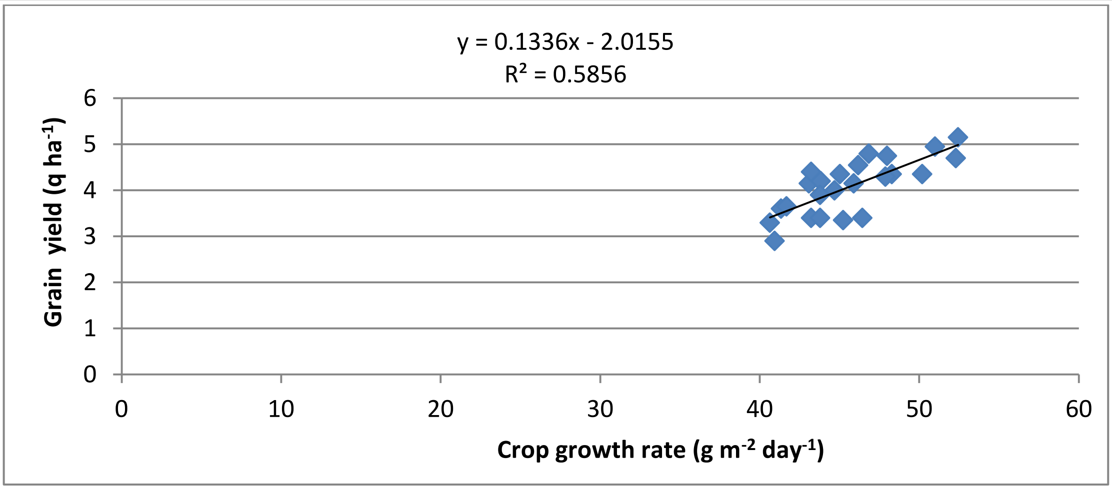

Fig. 4: Regression lines showing relation between grain yield (q ha^{-1}) with CGR (g m^{-2} day^{-1}) at maturity

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