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Flag leaf characteristics and relationship with grain yield and grain protein percentage for three cereals

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Abstract
An experiments were done to investigation the relationship between flag leaf characteristics for three cereal crop (Oat, Wheat and Rice) with grain yield and grain protein. Five cultivars from Oat (Wallaro, Carrolup, Wild oat, Hamel and Genzania), wheat (Ipa- 95, Ipa- 99, Abughraib, Letifia and Iraq) and rice (Anber, yassmen, Mishkab- 1, Mishkab- 2 and Baghdad) were evaluated for three seasons (2011, 2012 and 2013) in AL-Muthanna governorate, Iraq. The experiments were conducted in R.C.B. Design with three replicates.In general the relationship was positive and significant between grain yield and flag leaf area and nigitive between grain protein percentage with flag leaf area and grain yield for oat and rice crops.
Among the cultivars of oat, the different for studied characteristics were significant. The highest flag leaf area was observed in Wallaro cv. during 2012 arrived 77.01 cm^2 and fresh weight of flag leaf and grain yield for 2011 arrived (0.93 g) and (5.42 t/ ha^{-1}) for characteristics respectively. Wild oat cultivar gave lowest means for most trails expect grain protein which recorded high mean (12.96%) in season of 2013.

The studied trails were significantly affected by cultivars of wheat, Ipa-95 gave high flag leaf area arrived 51.23 cm^2 in season of 2013, and produced high means in fresh weight of flag leaf, total chlorophyll content and grain yield for 2013 arrived (0.69 g), (54.87 spad) and (5.54 t. ha^{-1}) for characteristics respectively. Letifia cv. gave lowest means for most trails expect grain protein which recorded high mean (13.94 %) in season of 2013.
The results showed differences between cultivars of rice during growing season. Meshkab-1 cv. gave high grain yield (4.98 ton/ ha^{-1}) in growing season 2013 while meshkab-2 cv. gave high mean (4.89 ton. ha^{-1}) in season 2012. Yassmen cv. was arrived (4.24 ton. ha^{1}) in season 2011. anber cv. gave highest average of grain protein percentage (12.09%) in the 2013. Yassmen cv. gave high flag leaf area (39.13 cm^2) and fresh weight of flag leaf area (0.49 g).

Keywords: Leaf area, grain yield, grain protein, wheat oat, rice

1. Introduction
One of the aims fundamental to all plant breeding programmes to cereals crop is to develop high varieties showing adaptability under different conditions. It is very important for long term planning and making projection to achieve sustainability in agricultural production.
The top three leaves especially flag leaf contributes most to grain yield [20, 13]. Greater carbohydrate translocation from vegetative plant parts to the spikelets [13] and larger leaf area index (LAI) during the grain filling period. Flag leaf has an important role in rice yield by increasing grain weight in amount of 41 to 43 percent. For this case flag leaf is activist leaf at grain filling period. Flag leaf area could be choosing as a factor for increasing rice grain yield [19]. Leaf area increase contributes for canopy development. As the leaf area increases, a greater photo synthetically active surface area becomes available and it would therefore be expected that the production rate would be greater the higher the leaf area.
Leaf area is indictor of potential grain yield [15] and broader and long leaves give higher grain yield in wheat [9], however, yield increase has been accompanied by lower total protein percentage of the grain [2]. Such yield- protein inverse relationship has also been reported by several other investigators [10]. Flag leaf area increase contribute by increasing chlorophyll content and fresh weight of flag leaf [21].
Grain yield increased in federroz 50 varieties due to increase in both flag leaf area and grain

maturity duration [1, 3, 7]. Grain yield correlated significant posatie and grain protein percentage negative with flag leaf area [1]. There was a positive correlation between flag leaf angle and photosynthesis material translocation and spikelets fertility increases also for increasing grain yield in rice, flag leaf must be wide and vertical [5]. In rice, 60-90% of total carbon in the panicles at harvest is derived from photosynthesis after heading, while 80% or more of nitrogen (N) in the panicles at harvest is absorbed before heading and remobilized from vegetative organs [11]. Leaf senescence during reproductive and maturity stages is directly related to biomass production and grain yield of rice crop [14, 20]. Also, during leaf senescence, chlorophyll content also decline but the rate of the decline is much slower than Rubisco content [4, 12].

Flag leaf contributes most to grain yield so we hypothesized that improvement of flag leaf morphophysiological characters for increasing grain yield may be occur by optimizing some agronomical treatments in rice. Therefore, the objective of this study was to evaluate the relationship between flag leaf characteristics with grain yield and grain protein for three cereals (Wheat, Oat and Rice) in three season.

2. Materials and Methods

Five cultivars from Oat (Wallaro, Carrolup, Wild oat, Hamel and Genzania), wheat (Ipa- 95, Ipa- 99, Abughraib, Letifia and Iraq) and rice (Anber, yassmen, Mishkab- 1, Mishkab- 2 and Baghdad) for three seasons (2011, 2012 and 2013) in AL-Muthanna governorate, south Iraq in soil its chemical and physical properties are shown in table (1), to investigation the relationship between flag leaf characteristics with grain yield and grain protein for three cereal. Experiments were conducted in R.C.B. Design with three replicates. Plot size of 2 x 1 meter with 20 cm row to row distance. Plots were planting date 15 November for wheat and oat while rice in 15 June. The fertilizer applied according to recommendations (200 kg N. ha in four split doses in stages planting, tillering, booting and flowering. 100 kg P. ha (Jedoa, 1995) and 60 kg K. ha (AL-Tahir, 2005) applied in equal two splits doses before planting and tillering stages. standard cultural practices were carried out until the crops were mature.

Flag leaf area, (used leaf area meter /LI-31000), fresh weight of flag leaf and total chlorophyll content, (used chlorophyll content meter/SPAD) were recorder at flowering from the primary tiller of 20 consecutive plants in middle rows were randomly selected of each plot. The grain yield was determined from harvest area 1 m^2 after adjusting for 14% moisture content. Grain protein percentage was examined by Crop Scan Li- 2000.

All variables were analyzed, variation, correlation and regression coefficient using SPSS program and means were separated by L.S.D at $P < 0.05$.

Table 1: Physical and Chemical properties of the experiment soil

Texture	pH	Ec. des./m	Soil structure %			Minerals %		
			Sand	Loam	Clay	N	K	P
Salty clay	7.62	4.11	29	38	43	0.74	1.11	0.20

3. Result and discussion

Oat crop

Among the cultivars, the different for studied characteristics were significant. The highest flag leaf area was observed in Wallaro cv. during 2012 arrived 77.01 cm^2 and fresh weight of flag leaf, total chlorophyll content and grain yield for 2011 arrived (0.93 g), (53.23 spad) and (5.42 $t.ha^{-1}$) for characteristics respectively. Wild oat cultivar gave lowest means for most trails expect grain protein percentage which recorded high mean (12.96%) in season of 2013. The variation between cultivars in characteristics related to genotype and the increasing of grain yield it was because of increase in fresh weight of flag leaf and total chlorophyll content. Grain yield for cultivars differ from season to other, Carrolup and Genzania cultivars gave high means in 2011 season (5.06 and 4.67 ton. ha^1) respectively, Wild oat cv. in 2012 (4.32 ton. ha^{-1}) and Hamel cv. in 2013 (4.77 ton. ha^{-1}) (table 2). Large variation among cultivars observed with [8, 18] in grain yield, Ashraf (2000) [1] in chlorophyll content and Muhammad *et al*. (2003) in flag leaf area.

According to correlation coefficients, grain yield was significantly and positively correlated with leaf area area (r = 0.806), fresh weight of flag leaf (r = 0.695) and total chlorophyll content (r = 0.567). The trails were used as selection criteria to improve oat cultivars with grain yield. All studied trails correlated with grain protein negative and significantly. Flag leaf area significantly and positively correlated with fresh weight of flag leaf (r = 0.548) and total chlorophyll content (r = 0.739). The variation in the relationship of flag leaf specifications, grain protein and grain yield because environmental differences. The relationship between other trails in a table (3) that were significant and positively mostly. Results of this research was demonstrated importance specifications flag leaf area in configure of grain yield as the most important aim in this research.

Wheat crop

The studied trails were significantly affected by cultivars (table 4). Ipa-95 cv. gave high flag leaf area arrived 51.23 cm^2 in season of 2013, and produced high means in fresh weight of flag leaf, total chlorophyll content and grain yield for 2013 arrived (0.69 g), (54.87 spad) and (5.54 t. ha^{-1}) for characteristics respectively. Letifia cv. gave lowest means for most trails expect grain protein percentage which recorded high mean (13.94%) in season of 2013. The variation between cultivars in characteristics related to genotype. Results shown that increase in grain yield was closely paralleled by changes in fresh weight of flag leaf and total chlorophyll content during different growth seasons. These results agreed with Muhammad *et al*. (2003) [3, 22].

In table (5) significant and positive correlation coefficients between grain yield and flag leaf area (r = 0.9878), fresh weight of flag leaf (r = 0.939) and total chlorophyll content r = 0.991). The results showed all relationship were positive and significant among the studied trails except grain protein that was not relationship with all trails. Flag leaf area correlated positive significant with fresh weight of flag leaf (r = 0.965) and total chlorophyll content (r = 996). Most of all studied

trails were correlated significantly and positively.

Rice crop

The results showed differences between cultivars of rice during growing season. Meshkab-1 cv. and Baghdad cv. Gave high grain yield (4.98 and 3.93 ton. ha^{-1}) respectively in growing season 2013 while meshkab-2 cv. and Anber cv. Gave high mean (4.89 and 3.52 ton. ha^{-1}) respectively in season 2012. Yassmen Cv. was arrived (4.24 ton. ha^{-1}) in season 2011. Data of grain protein differ for cultivars and growing season and the highest average for the Yassmen cultivar (12.09 %) in the 2013 season. Meshkab-1 gave high flag leaf area (39.13 cm^2) and high means for fresh weight of flag leaf with yassmen cv. (0.49 g) and total chlorophyll content with Baghdad cv. (45.67 spad). The increase in grain yield was obtained because of the increase in flag leaf area with no large reducing in weight of flag leaf and total chlorophyll content (table 6). These results agree with Peng *et al*. (1993), IRRI (1995), Mohammad *et al*. (2002) and Jenning *et al*. (2003).

According to correlation coefficients, grain yield was significantly and positively correlated with leaf area area (r = 0.623) and fresh weight of flag leaf (r = 0.579). Total chlorophyll content it did not correlate significantly with grain yield (r = 0.438). Grain yield correlated with grain protein negative and significantly(r = -0.693). Flag leaf area significantly and positively correlated with fresh weight of flag leaf (r = 0.845) and total chlorophyll content (r = 0.719). The relationship between other trails in a table (7) that were significant and positively mostly. All trails associated with flag leaf is importance in formation of grain yield to be good attention by. The results showed all trails of flag leaf correlated negatively and non-significant with grain protein (table 7).

Scatter plot

Results of scatter plot showed long variation between of cultivars of oat, wheat and rice during growth seasons for all studied trails (flag leaf area, fresh weight flag leaf, total chlorophyll content, grain yield and grain protein). b values differed from trail to other during growth seasons, same cultivars gave increase and other cultivars reduce in means of studied characteristics during growth seasons especially with wheat and rice crop. It suggests to cultivars need to be tested at along with growth seasons for evaluation of these characteristics reflects that performance of these characteristics was more inconsistent over growth seasons this because of difference of response of cultivars from growing seasons to other (figure 1 to 15).

4. Conclusion

From the results of experiments conclude the following;

1. Results of correlation of all crops showed that grain yield correlated significant and positive with flag leaf area, fresh weight of flag leaf and total chlorophyll content. In general correlation coefficients were positive and significant among the studied trails except grain protein that was not relationship with all trails.
2. The cultivars differed themselves with different growing seasons Wallaro cv. was observed high grain yield for 2011 arrived 5.42 t/ ha, while in wheat given Ipa-95 high mean reached 5.54 t/ ha, rice cultivars Meshkab- 1gave high mean reached 4.98 t/ ha.

5. Recommendation

1. The cultivation Oat cultivars (Ipa- 95), wheat cultivars (Ipa- 95) and rice cultivars (Meshkab- 1) because provide highest grain yield, leaf area area, fresh weight of flag leaf and total chlorophyll content.
2. Cultivars need to be tested at more locations along with growth seasons for evaluation of these characteristics reflects that performance of these characteristics was more inconsistent over growth seasons.

Table 2: effect cultivars of Oat in studied trails in three growth seasons.

Genotype	Season	Flag leaf area (cm2)	Fresh weight of flag leaf (g)	Total chlorophyll contents (spad)	Grain yield (t/ha)	Grain protein (%)
Wallaro	2011	76.12	0.93	53.23	5.42	11.64
	2012	77.01	0.88	52.23	5.21	11.72
	2013	73.45	0.74	50.11	4.98	11.89
Carrolup	2011	75.16	0.81	51.36	5.06	11.81
	2012	75.34	0.83	49.80	4.91	11.92
	2013	73.23	0.73	46.34	4.72	11.98
Wild Oat	2011	68.83	0.72	48.71	4.21	12.81
	2012	66.89	0.73	45.67	4.32	12.88
	2013	69.78	0.78	43.89	4.06	12.96
Hamel	2011	70.22	0.74	50.56	4.45	12.67
	2012	72.45	0.76	49.56	4.67	12.73
	2013	74.56	0.77	50.67	4.77	12.65
Genzania	2011	73.95	0.69	50.78	4.67	11.94
	2012	74.12	0.70	53.22	4.59	11.74
	2013	76.45	0.78	55.78	4.62	11.68
L.S.D (0.05)	2011	2.11	0.10	2.67	0.43	0.12
	2012	3.01	0.08	2.77	0.51	0.13
	2013	2.56	0.11	2.83	0.56	0.15

Table 3: Coefficients of correlation among investigated trails for oat crop

		F.A	F.W	T.C	G.Y	G.P
F.A	Pearson Correlation		.548*	.739**	.806**	-.847**
F.W	Pearson Correlation	.548*		.299	.695**	-.379
T.C	Pearson Correlation	.739**	.299		.567*	-.701**
G.Y	Pearson Correlation	.806**	.695**	.567*		-.758**
G.P	Pearson Correlation	-.847**	-.379	-.701**	-.758**	
* , ** . Correlation is significant at the 0.05 and 0.01 level respectively						

Table 4: Effect cultivars of Wheat in studied trails in three growth seasons

Genotype	Season	Flag leaf area (cm2)	Fresh weight of flag leaf (g)	Total chlorophyll contents (spad)	Grain yield (t/ha)	Grain protein (%)
IPA- 95	2011	48.90	0.63	52.34	5.08	12.75
	2012	49.34	0.66	53.23	5.23	12.57
	2013	51.23	0.69	54.78	5.54	12.23
IPA- 99	2011	46.78	0.57	51.34	5.21	12.63
	2012	44.89	0.54	50.34	4.98	13.13
	2013	42.45	0.51	46.56	4.71	13.31
Abughraib	2011	44.12	0.47	52.78	5.42	13.42
	2012	45.37	0.50	51.34	5.52	13.20
	2013	43.46	0.47	48.43	5.37	13.41
Letifia	2011	45.34	0.52	46.23	4.89	13.63
	2012	44.23	0.49	48.28	4.71	13.92
	2013	42.45	0.43	48.68	4.39	13.94
Iraq	2011	46.78	0.54	49.78	4.86	13.52
	2012	45.78	0.51	50.34	4.62	13.73
	2013	47.34	0.54	51.78	5.11	13.82
L.S.D (0.05)	2011	1.56	0.12	0.58	0.23	0.15
	2012	1.67	0.09	0.66	0.27	0.17
	2013	1.66	0.13	0.64	0.25	0.18

Table 5: Coefficients of correlation among investigated trails for Wheat crop

		F.A	F.W	T.C	G.Y	G.P
F.A	Pearson Correlation		.965**	.996**	.987**	.197
F.W	Pearson Correlation	.965**		.948**	.939**	.258
T.C	Pearson Correlation	.996**	.948**		.991**	.153
G.Y	Pearson Correlation	.987**	.939**	.991**		.168
G.P	Pearson Correlation	.197	.258	.153	.168	
*** , ** . Correlation is significant at the 0.05 and 0.01 level respectively**						

Table 6: effect cultivars of rice crop in studied trails in three growth seasons

Genotype	Season	Flag leaf area (cm2)	Fresh weight of flag leaf (g)	Total chlorophyll contents (spad)	Grain yield (t/ha)	Grain protein (%)
Anber	2011	26.45	0.28	36.13	3.01	11.72
	2012	28.12	0.32	40.30	3.52	11.88
	2013	27.34	0.30	39.46	3.15	12.09
Yassmen	2011	39.13	0.49	44.78	4.24	11.67
	2012	37.32	0.40	42.39	3.67	11.88
	2013	35.56	0.38	39.23	3.37	11.99
Meshkab- 1	2011	37.12	0.36	40.67	4.24	11.82
	2012	38.29	0.42	42.78	4.52	11.62
	2013	38.56	0.43	43.90	4.98	11.49
Meshkab- 2	2011	34.68	0.33	38.18	4.22	11.89
	2012	36.01	0.38	41.53	4.89	11.55
	2013	35.89	0.36	40.98	4.40	11.34
Baghdad	2011	36.67	0.37	41.38	3.16	11.79
	2012	35.67	0.35	43.56	3.46	12.03
	2013	37.45	0.38	45.67	3.93	11.87
L.S.D (0.05)	2011	1.39	0.05	0.45	0.35	0.88
	2012	1.67	0.07	0.59	0.41	0.52
	2013	1.56	0.65	0.61	0.38	0.72

Table 7: Coefficients of correlation among investigated trails for rice crop

		F.A	F.W	T.C	G.Y	G.P
F.A	Pearson Correlation		.845**	.719**	.623*	-.332
F.W	Pearson Correlation	.845**		.756**	.579*	-.329
T.C	Pearson Correlation	.719**	.756**		.438	-.143
G.Y	Pearson Correlation	.623*	.579*	.438		-.693**
G.P	Pearson Correlation	-.332	-.329	-.143	-.693**	
* , ** . Correlation is significant at the 0.05 and 0.01 level respectively						

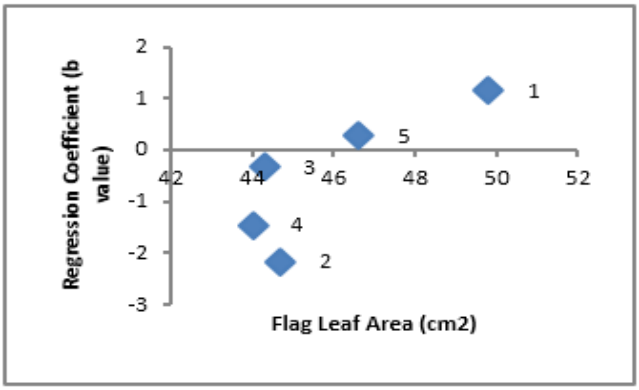

Fig 1: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and flag leaf area in oat

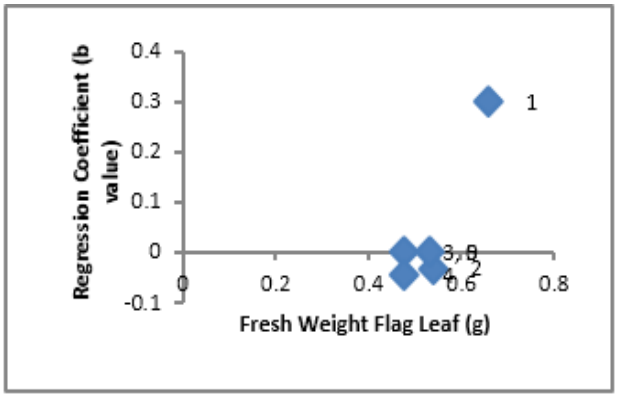

Fig 2: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and fresh weight flag leaf in oat

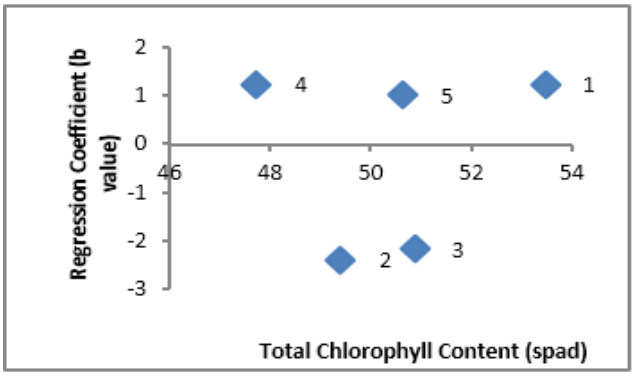

Fig 3: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and total chlorophyll content in oat

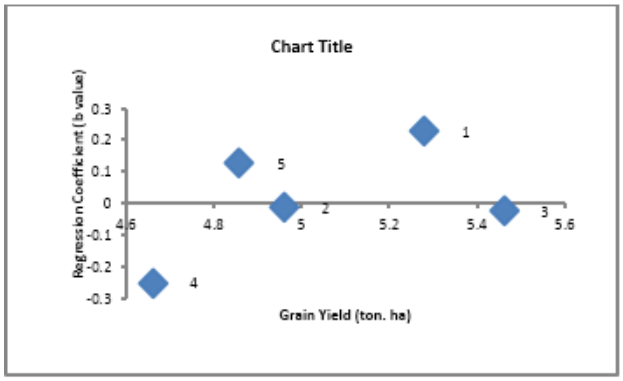

Fig 4: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and grain yield in oat

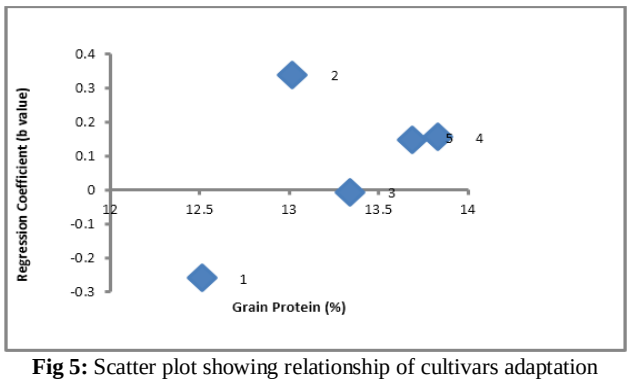

Fig 5: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and grain protein percentage in oat

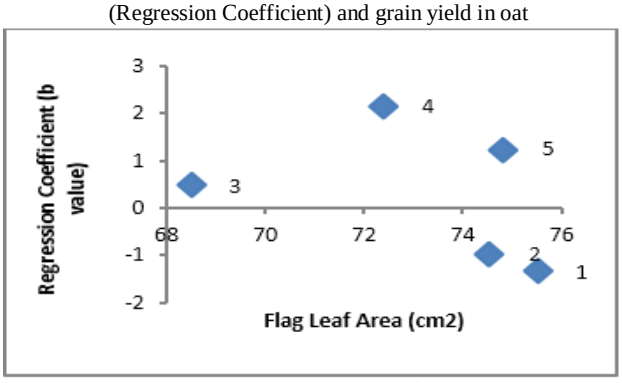

Fig 6: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and flag leaf area in wheat

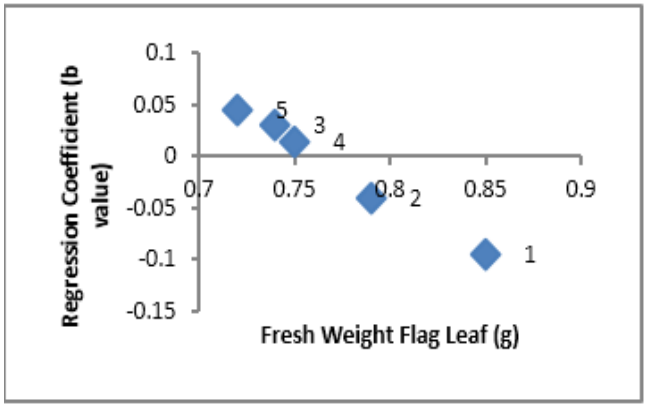

Fig 7: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and fresh weight flag leaf in wheat

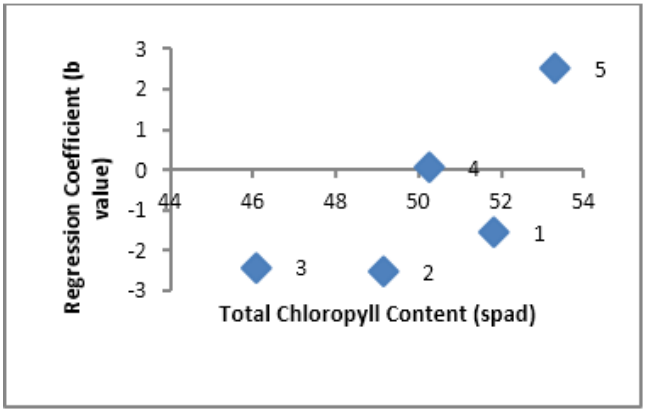

Fig 8: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and total chlorophyll content in wheat

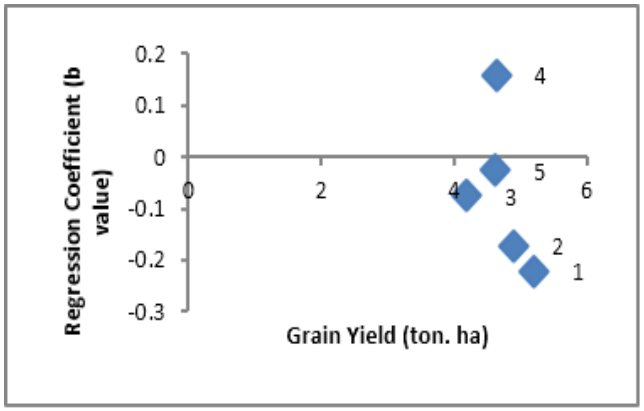

Fig 9: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and grain yield in wheat

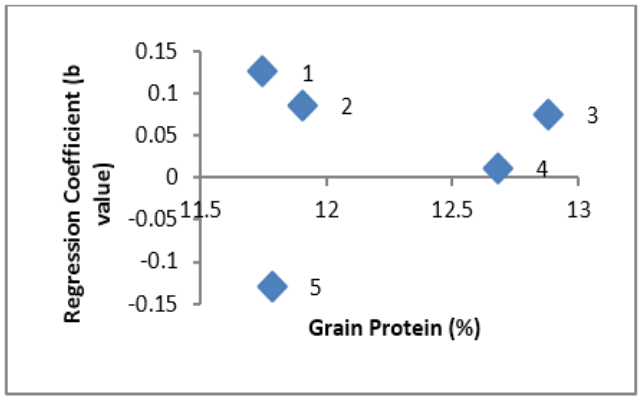

Fig 10: Scatter plot showing relationship of cultivars adaptation Regression Coefficient) and grain protein percentage in wheat

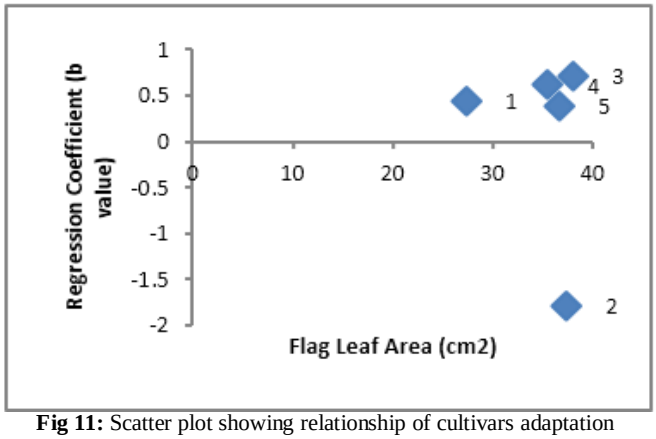

Fig 11: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and flag leaf area in rice

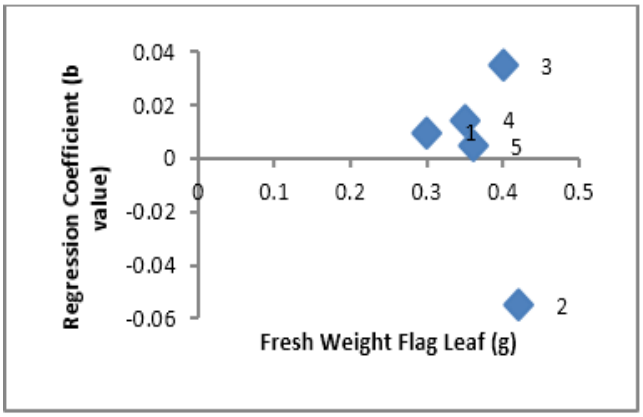

Fig 12: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and fresh weight flag leaf in rice

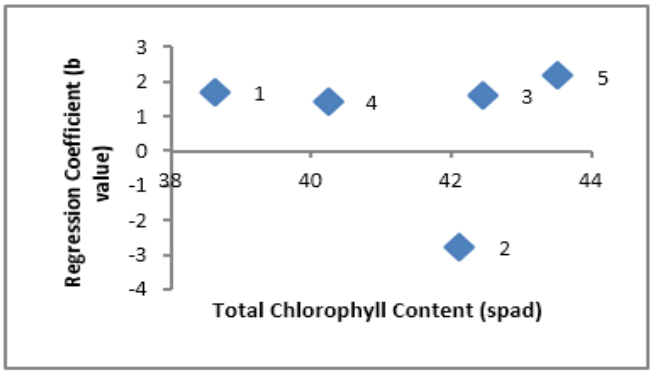

Fig 13: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and total chlorophyll content

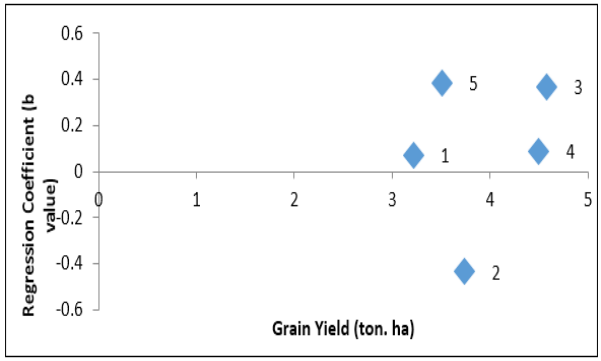

Fig 14: Scatter plot showing relationship of cultivars adaptation (Regression Coefficient) and grain yield in rice

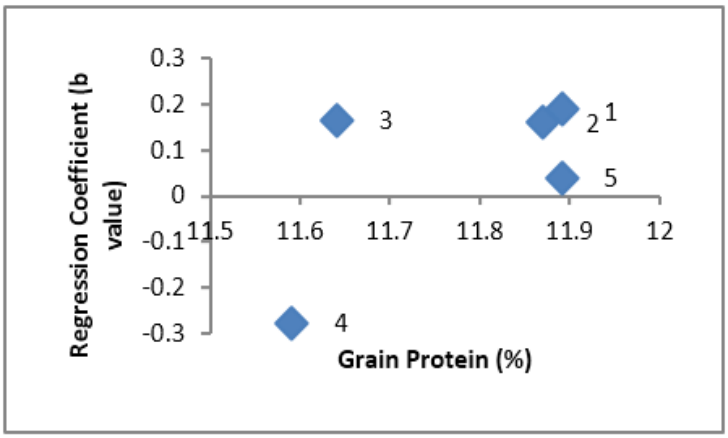

Fig 15: Scatter plot showing relationship of cultivars adaptation(Regression Coefficient) and grain protein percentage in rice

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