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Using Path Analysis to Predict Wheat Plant Loss (*Triticum Aestivum* L.) by Knowing the Tensity of the Weeds (*Bromus Rigidus*)

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A B S T R A C T
The research explores the use of path analysis to predict the effect of brome grass (Bromus rigidus Roth) density on wheat (Triticum aestivum L.) yield loss. It also studies the relationship between weed density and wheat productivity. The research was conducted during the fall 2020 and spring 2021 seasons. Data were collected from experiments conducted under different densities of weeds and wheat. The statistical analysis program SPSS was used to determine the effect of competition on the amount of loss in wheat and brome productivity, using the Cousens equation and to calculate the competition coefficient between species using the Steward equation. Then, path analysis was used to predict the effect of internal and external variables on plant traits, biomass, and productivity. The results showed that increasing grass density led to a decrease in wheat productivity. The study emphasizes the importance of taking physiological factors into account in crop productivity. Recommendations include implementing measures to control weed density, adjusting wheat planting density to compete effectively with weeds, using weed-resistant wheat varieties, adopting comprehensive farm management practices, and conducting further research to enhance understanding of the interaction between wheat and weeds.

Keywords: Soft wheat (Triticum aestivum L.), (Bromus rigidus Roth.), Competition, Path analysis.

استخدام تحليل المسار للتنبؤ بفقدان نباتات القمح (Triticum aestivum L.) من خلال معرفة كثافة الحشائش(Bromus rigidus)

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الملخص
يستكشف هذا البحث استخدام تحليل المسار للتنبؤ بتأثير كثافة حشيشة البروموس (Bromus rigidus Roth) على فقد محصول القمح (Triticum aestivum L.). كما يدرس العلاقة بين كثافة الحشائش وإنتاجية القمح. أجري البحث خلال مواسم الخريف 2020 والربيع 2021. تم جمع البيانات من تجارب أجريت تحت كثافات مختلفة من الحشائش والقمح. تم استخدام برنامج التحليل الإحصائي SPSS لتحديد تأثير المنافسة على مقدار الفقد في إنتاجية القمح والبروموس، باستخدام معادلة كاوزنز ولحساب معامل المنافسة بين الأنواع باستخدام معادلة ستيوارد بعد ذلك، تم استخدام تحليل المسار للتنبؤ بتأثير المتغيرات الداخلية والخارجية على صفات النبات والكتلة الحيوية والإنتاجية.
أظهرت النتائج أن زيادة كثافة الحشائش أدت إلى انخفاض إنتاجية القمح. تؤكد الدراسة على أهمية أخذ العوامل الفسيولوجية في الاعتبار في إنتاجية المحاصيل. وتشمل التوصيات تنفيذ تدابير للسيطرة على كثافة الحشائش، وضبط كثافة زراعة القمح للمنافسة بشكل فعال مع الحشائش، واستخدام أصناف قمح مقاومة للحشائش، واعتماد ممارسات إدارة المزرعة الشاملة، وإجراء مزيد من البحث لتعزيز فهم التفاعل بين القمح والحشائش.

الكلمات المفتاحية: القمح الطري (Triticum aestivum L.)، البروموس الصلب (Bromus rigidus Roth.)، المنافسة، تحليل المسار

1. Introduction

The impact of weeds on crops can lead to productivity losses given the competition that occurs between them. Scientists have developed mathematical processes and equations for estimating and predicting crop loss based on empirical data gathered from practical experiments on crops and weeds.

The Cousins equation is widely used to describe crop loss based on weed density. This mathematical model is based on the rectangular hyperbolic segment model developed by Cousens in [1].

In addition, it uses path analysis that facilitates the analysis of assumed relationships between elements of crop productivity. This analysis helps to uncover the impact of linkages between crop components and provides a relative estimation of the importance of those relationships in crop productivity. It combines partial regression coefficients that are considered a pathway of influencing factors and depend on the scales of the original units. The path analysis demonstrates the importance of these linkages and provides a direct comparison of crop components and yields [2] explained that increasing crop yields without affecting other components requires studying the interrelationships between them and identifying the most influential component on yields to be used as a criterion for selection. Therefore, this research aims to study the phenotypic relationships between traits (Phenotypic Correlation Coefficient) and path analysis coefficients to identify traits that are more related and contribute more to grain yields.

Path analysis can be used to understand causal relationships between different variables and their impact on competition between two adjacent plants. In the context of plant competition, the path analysis can be used to identify factors that influence the competitiveness of each plant and their impact on the productivity of each plant.

Path analysis has proven to be a valuable tool in understanding the complex dynamics of competition between adjacent plants and elucidating the factors that influence their productivity. To conduct a path analysis in the context of competition between two neighbouring plants, the following steps can be undertaken [3]:

1. Variable Identification: It is imperative to identify the variables associated with plant competition. These variables may include the number of spikelets, grain weight, plant height, plant biomass, and other indicators related to productivity and competitiveness.
2. Data Collection: Relevant data pertaining to the identified variables must be collected. This data can be obtained through field measurements, laboratory experiments, or from previously published and peer-reviewed studies.
3. Data Analysis: The collected data should be analyzed using appropriate statistical techniques, such as path analysis or structural equation modeling. The relationships among the variables are examined, and the strength and causal patterns between them are estimated.
4. Result Interpretation: The results of the analysis are interpreted to elucidate how the variables influence competition between plants. The factors that most significantly impact plant productivity and competitiveness can be identified, and the relationships among them can be elucidated.

Through this methodological approach, path analysis can be employed to analyze and interpret the competitive dynamics between adjacent plants and to understand the factors that affect their productivity and competitiveness, [4] pioneered the use of path analysis to study the effect of weed competition on crops, and since then, this analytical technique has been widely adopted in the fields of agriculture, horticulture, and ecology. Notably [5] developed the pathway analysis for studying the impact of weed competition on rice crop components [6].

1.2 Previous Studies:

Numerous studies have employed path analysis to investigate the relationship between weed density and wheat crop loss. These studies have provided insights into the intricate dynamics between these variables, [7] revealed that increasing the density of Bromus tectorum leads to a decline in wheat productivity, with losses ranging from 3% to 19% when the Bromus density is between 5 and 40 plants per square meter. [8] conducted a study on different wheat varieties and found a strong positive correlation between the harvest and tillage index of each plant, spike length, and the grain yield of each plant.[9] highlighted the importance of weight testing and grain/spike weight in improving grain productivity in wheat.[10] reported a positive relationship between grain yield and spike/m2, as well as other components such as plant height, spike weight, and spike length.

Furthermore, [11] utilized a mutated group of wheat in their study in 2020 and found that the number of ploughs per plant significantly affects grain productivity per plant.[12] conducted a meta-analysis on wheat phenotype indicators and discovered that the overall response to biotic stress includes a decrease in grain production and an increase in different enzymes and compounds associated with the stress response. In a study conducted by [13], path analysis was employed to model the impact of biofertilizers on wheat yields, and the results indicated positive impacts in some areas and negative impacts in others.

These studies provide substantial evidence regarding the relationship between various factors and wheat productivity, contributing to a better understanding of the factors influencing the increase in biomass and the improvement of crop quality.

1.3 Research objectives:

1- Determine the relationship between weed density (*Bromus rigidus*) and wheat plant loss (*Triticum aestivum* L.).
2- Use of path analysis to predict and interpret wheat plant loss based on weed density.

1.4 The importance of the study:

Bromus rigidus is one of the common weeds in wheat crops, and causes significant productivity and crop quality problems. The weed competes with the wheat plant for water, nutrients, and light, reducing the growth and productivity of the wheat plant. In addition, the presence of the weed at a high density can lead to low grain quality and increase agricultural costs to combat it.

Therefore, the importance of this research lies in understanding the relationship between weed density and wheat plant loss, as this helps to improve weed management strategies and reduce losses. Also, by understanding this relationship, the efforts of farmers and specialists can be directed towards developing innovative agricultural techniques to control the weed and reduce its negative impact on wheat productivity.

In addition, the use of path analysis provides us with a strong analytical framework for understanding the influencing factors and causal relationships in the wheat crop ecosystem. We can analyze the various factors that influence the prevalence and impact of the weed, such as the environmental conditions and the physiological factors of the wheat plant. This helps us identify the key factors to focus on in our weed control efforts and boost wheat productivity.

In general, it can be said that this research contributes to the development of our knowledge and understanding of the biological and environmental interactions between the weed and the wheat plant, enabling us to take effective actions to control the weed and improve the yield and quality of the crop.

2. Method and Materials:

This study was conducted using a method of analyzing competition between variable plant densities. Data were collected from experiments conducted under different densities of wheat plants and Promes. The effect of these two plants on each other was studied by the change in growth density and its effect on morphological and productive features such as the number of spikelets, the weight of the grains, the general weight of the plant, the number of branches, the length of the plant, and the number of leaves.

The experiments were conducted in the Department of Botany, Faculty of Science, Zawiya University, during the fall 2020 and spring 2021 semesters. *Triticum aestivum* L., and were planted in soil from the study site.

The soil was purified using a 1 mm diameter sieve to remove the seeds of plants and weeds. It was then sterilized by heating it for 4 hours at a temperature between 70 and 80 degrees Celsius. Subsequently, the soil was placed in a pot with a diameter of 25 cm and a height of 35 cm and filled with soil up to a height of 20 cm to allow room for irrigation. The pots were placed in an area surrounded by a net to protect them from birds. Improved wheat seeds resistant to insect and fungal pests of research grade 208 were used and obtained from the Municipality of Agriculture in Sidi El Massry - Tripoli. As for the Promise seeds, they were obtained from the previous year's crop from fields that had not been treated with pesticides during the three years preceding the study. The samples were formed as shown in the following tables:

Table 1 Samples of estimating the impact of competition on wheat **(W)**

Samples	W0	W1	W2	W3	W4	W5	W6
Wheat Density	6	6	6	6	6	6	6
Bromus Density	0	1	2	3	4	5	6

Table 2 Samples to estimate the impact of competition on promos **(S)**

Samples	S0	S1	S2	S3	S4	S5	S6
Bromus Density	6	6	6	6	6	6	6
Wheat Density	0	1	2	3	4	5	6

Irrigation system: The pots were irrigated on the first day of planting and whenever the need arises after that.
Fertilization: Fertilize the pots when planting once, and then fertilize once a month to meet the needs of plants of basic elements (N P K).
Then I took measurements: the length and number of

branches, leaves, nodes, and phalanges of plants on a weekly basis until the plants stopped growing. Observations of the change in the different characteristics of plants were recorded such as recording the number of spikelets in each sample, the grains in the spikelets for each sample and the weight of the thousand grains to estimate the rate of production. The average dry weight of each pot's plants was set at the end of the experiment.

The impact of competition on the amount of loss in wheat productivity and Bromus was determined using an equation

$$Y_L = \frac{iD}{1 + \frac{iD}{a}}$$

Where:

Y_L: Relative crop loss.

D: Density of weed.

i: The variable that represents the first slope of the curve.

a: represents the maximum crop loss at the highest density level of the weed.

and calculating the coefficient of competition between species, following the example of Steward using the equation:

$$a = \frac{bc-w}{bc-c} ,$$

where:

a: Coefficient of contention,

$bc - w$: species competition coefficient.

$$bc - w = \frac{Y_{ij}}{Y_{jj}}$$

$bc - c$: intraspecific competition coefficient

$$bc - c = \frac{Y_{ij}}{Y_{ii}}$$

Y_{ij}: Dry weight of crop and herb in case of competition.

Y_{jj}: Dry weight of herb (Witness).

Y_{ii}: Dry weight of crop (Witness).

2.1 Statistical processing of data.

The data were processed using Statistical Package for Social Science SPSS software and using One way analysis of variance at the lowest significant difference of 5% between the recorded measurements, and then using path analysis to predict the impact of internal variables and external variable on plant characteristics, biomass and productivity.

3. Results and discussion

3.1 Productivity forecasting and route analysis

The competing factor has two types of effects on wheat productivity - a direct effect (DE) and an indirect effect (IE)- and these factors and their relationship to each other can be analyzed to predict plant productivity by determining the resulting effect on the general weight of the plant when any factor is increased by one unit. The external factor directly and indirectly affects productivity through its influence on internal factors, which in turn affect the biomass of the plant, which represents productivity.

Figure.1 shows that the increase in the density of promos did not have a significant impact on the length of wheat leaves, but when the number of promos plants is increased by one unit, the length of wheat leaves will decrease by 0.30%. The increase in the density of promos did not have a significant impact on the length of wheat, but by increasing the density of promos one unit, the length of wheat decreases by 0.04%. The increase in the density of promos did not have a significant impact on the length of wheat ears, but by increasing the density of Bromus one unit, the length of wheat ears decreases by 0.18%.

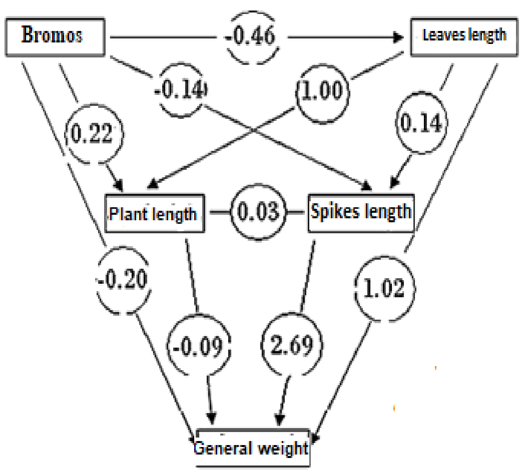

Figure 1 The path of factors affecting wheat productivity

The increase in the density of proms had a significant impact on the general weight of wheat (productivity). When Bromus is increased by one unit, the productivity of wheat is reduced by 1.45%.

Figure 2 shows that the increase in wheat density did not have a significant impact on the length of the Bromus leaves, but when the wheat plant is increased by one unit, the length of the Bromus leaves will decrease by 0.17%. Increasing the density of wheat had a significant impact on the length of the plant. When wheat is increased by one unit, the length of the Bromus is reduced by 0.72%. The increase in wheat density did not have a significant impact on the length of the Bromus but when the wheat plant is increased by one unit, the length of the Bromus will decrease by 0.45%.

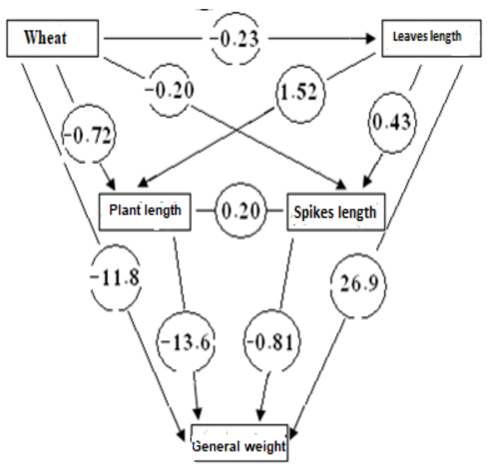

Figure 2 The path of factors affecting the productivity of the Bromus

The increase in wheat density had a significant impact on the (biomass) weight of the Bromus (productivity). When wheat is increased by one unit, the productivity of the Bromus is reduced by 1.93%.

3.2 Competition coefficient

Table.3 data indicate that the coefficient of competition between wheat plants (intra-specific competition) at the highest density of Promus herb was 3.03, while the coefficient of competition between Promes plants at the highest density of wheat 1.49, and the coefficient of inter-specific competition was higher in Promes plants than in wheat plants, and the average coefficient of competition was 0.45 in wheat, and in Promes 2.21, which means that the competitiveness of Promes is almost twice as strong compared to the wheat competition of Promes, which is on average 0.45 times. These results are close to what authors reached in an experiment [14] to measure the competition between wheat and wild radish, where he showed that the competitiveness of wild radish grass is nine times compared to the competition of wheat for wild radish, which was 0.52 times.

Table 3 Competition Factor

Density	Inside Type b c-c		between types b w-c		**a** = b w-c / b c-c	
	Wheat	Promise.	Wheat	Promise.	Wheat	Promise.
1 – 6	2.94	12.2	1.51	4.22	0.51	1.99
.6.2	3.84	1.51	1.35	3.33	0.35	20.2
3–6	3.63	1.43	1.60	3.30	0.44	2.30
4-6	3.53	1.45	1.39	20.3	0.39	20.2
5 6	2.80	1.40	1.55	3.49	0.55	2.49
6 6	3.03	1.49	1.49	3.03	0.49	2,03
Moderate					0.45	2,21

4. Conclusion:

The research explores the use of path analysis to predict the effect of *Bromus rigidus* Roth density on wheat crop loss (*Triticum aestivum* L.). It also examines the relationship between grass density and wheat productivity. The research was conducted during the fall 2020 and spring 2021 seasons. Data were collected from experiments conducted under different densities of grass and wheat. Statistical analysis program (SPSS) was used. The impact of competition on the amount of loss in wheat productivity and promos was determined using the Cousens equation [1], and the calculation of the coefficient of competition between species with the Steward equation [15]. Path analysis is then used to predict the influence of internal and external variables on plant traits, biomass, and productivity. The results found that increasing the density of the herb leads to a decrease in wheat productivity. The study emphasizes the importance of taking into account physiological factors in crop productivity. Recommendations include implementing measures to control the density of weeds, adjusting the intensity of wheat cultivation to effectively compete with weeds, using weed-resistant wheat varieties, adopting comprehensive farm management practices, and conducting further research to enhance understanding of the interaction between wheat and weeds.

5. Appendix

Path analysis

Regression Analysis: Y1 versus S

The regression equation is

Y1 = 21.4 - 0.457 S

Predictor	Coef	SE Coef	T	P
Constant	21.4286	0.8293	25.84	0.000
LS	-0.4571	0.2300	-1.99	0.104

S = 1.217 R-Sq = 44.1% R-Sq(adj) = 33.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	5.851	5.851	3.95	0.104
Residual Error	5	7.406	1.481		
Total	6	13.257			

Regression Analysis: Y2 versus S; Y1

The regression equation is

Y2 = 31.9 + 0.223 S + 1.00 Y1

Predictor	Coef	SE Coef	T	P
Constant	31.93	24.62	1.30	0.264
S	0.2230	0.7875	0.28	0.791
Y1	1.002	1.145	0.88	0.431

S = 3.115 R-Sq = 18.8% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	2	8.979	4.490	0.46	0.659
Residual Error	4	38.804	9.701		

Total 6 47.783

Source	DF	Seq SS
S	1	1.546
Y1	1	7.433

Regression Analysis: Y3 versus S; Y1; Y2

The regression equation is
Y3 = 7.36 - 0.136 S + 0.0136 Y1 + 0.0341 Y2

Predictor	Coef	SE Coef	T	P
Constant	7.363	1.778	4.14	0.026
S	-0.13578	0.04820	-2.82	0.067
Y1	0.01357	0.07571	0.18	0.869
Y2	0.03413	0.03030	1.13	0.342

S = 0.1888 R-Sq = 86.6% R-Sq(adj) = 73.2%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	0.69208	0.23069	6.47	0.080
Residual Error	3	0.10689	0.03563		
Total	6	0.79897			

Source	DF	Seq SS
S	1	0.63000
Y1	1	0.01689
Y2	1	0.04519

Regression Analysis: Y4 versus S; Y1; Y2; Y3

The regression equation is
Y4 = - 32.9 - 0.204 S + 1.02 Y1 - 0.087 Y2 + 2.69 Y3

Predictor	Coef	SE Coef	T	P
Constant	-32.91	35.83	-0.92	0.455
S	-0.2035	0.7156	-0.28	0.803
Y1	1.0200	0.5919	1.72	0.227
Y2	-0.0867	0.2811	-0.31	0.787
Y3	2.694	4.490	0.60	0.609

S = 1.468 R-Sq = 90.3% R-Sq(adj) = 71.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	4	40.207	10.052	4.67	0.184
Residual Error	2	4.309	2.155		
Total	6	44.516			

Source	DF	Seq SS
S	1	31.080
Y1	1	8.349
Y2	1	0.001
	1	0.776

1- Determined equations

$$Y_1 = c + b_1 s$$
$$Y_2 = c + b_2 s + b_3 Y_1$$
$$Y_3 = c + b_4 s + b_5 Y_1 + b_6 Y_2$$
$$Y_4 = c + b_7 s + b_8 Y_1 + b_9 Y_2 + b_{10} Y_3$$

where:
Y1= *leaves length*
Y2 = *Plant length*
Y3 = *Spike length*
Y4 = Total weight
Y1, Y2, Y3, Y4 Endogenous variable
S = Bromus
S Exogenous variable

2- Estimated equations
Y1 = 21.4 - 0.457 *S*
Y2 = 31.9 + 0.223 S + 1.00 Y1
Y3 = 7.36 - 0.136 S + 0.0136 Y1 + 0.0341 Y2
Y4 = - 32.9 - 0.204 S + 1.02 Y1 - 0.087 Y2 + 2.69 Y3

3-Estimated: path coefficients actual correlation P-value

b1 (P21)	-0.46	-0.66	(0.104)
b2 (P31)	0.22	-0.18	(0.700)
b3 (P32)	1.00	0.41	(0.355)
b4 (P41)	-1.14	-0.88	(0.008)
b5 (P42)	0.14	0.70	(0.081)
b6 (P43)	0.03	0.43	(0.334)
b7 (P51)	-0.20	-0.84	(0.019)
b8 (P52)	1.02	0.88	(0.009)
b9 (P53)	-0.09	0.33	(0.476)
b10(P54)	2.69	0.85	(0.014)

4- Compare actual and reproduced correlations:

DE
r12 = (-0.46)[-0.66] = 0.30

DE IE
r13 = 0.22 + (1.00)(-0.46) = (-0.24)[-0.18] = 0.04

DE IE IE IE
r14=-0.14+(0.14)(-0.46)+(0.22)(0.03)+(0.03)(1.00)(-0.46)=(-0.21)[-0.88]=0.18

DE IE IE IE
r15 = -0.02 + (-0.09)(0.22) + (-0.09)(1.00)(-0.46) + (-0.09)(0.03)(-0.14) +
IE IE IE
(-0.09)(0.03)(0.14)(-0.46)+(2.69)(0.03)(0.22)+ (2.69)(0.03)(1.00)(-0.46)
IE IE IE
+(2.69)(-0.14)+(2.69)(0.14)(-0.46)+ (1.02)(-0.46) = (-1.22)[-0.84] = 1.45

Regression Analysis: X1 versus w

The regression equation is
X1 = 12.6 - 0.229 w

Predictor	Coef	SE Coef	T	P
Constant	12.6000	0.3290	38.30	0.000
w	-0.22857	0.09125	-2.50	0.054

S = 0.4828 R-Sq = 55.7% R-Sq(adj) = 46.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	1.4629	1.4629	6.27	0.054
Residual Error	5	1.1657	0.2331		
Total	6	2.6286			

Regression Analysis: X2 versus w; X1

The regression equation is
X2 = 26.0 - 0.717 w + 1.52 X1

Predictor	Coef	SE Coef	T	P
Constant	26.017	4.161	6.25	0.003
w	-0.7169	0.1010	-7.10	0.002
X1	1.5196	0.3296	4.61	0.010

S = 0.3559 R-Sq = 98.5% R-Sq(adj) = 97.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	2	34.408	17.204	135.81	0.000
Residual Error	4	0.507	0.127		
Total	6	34.914			

Source	DF	Seq SS
w	1	31.716
X1	1	2.692

Regression Analysis: X3 versus w; X1; X2

The regression equation is

X3 = 1.2 - 0.20 w + 0.43 X1 + 0.20 X2

Predictor	Coef	SE Coef	T	P
Constant	1.18	61.69	0.02	0.986
w	-0.201	1.682	-0.12	0.912
X1	0.428	3.741	0.11	0.916
X2	0.196	2.259	0.09	0.936

S = 1.608 R-Sq = 50.3% R-Sq(adj) = 0.5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	7.834	2.611	1.01	0.497
Residual Error	3	7.754	2.585		
Total	6	15.589			

Source	DF	Seq SS
w	1	7.201
X1	1	0.614
X2	1	0.019

Regression Analysis: X4 versus w; X1; X2; X3

The regression equation is

X4 = 313 - 11.8 w + 26.9 X1 - 13.6 X2 - 0.81 X3

Predictor	Coef	SE Coef	T	P
Constant	313.2	186.6	1.68	0.235
w	-11.837	5.099	-2.32	0.146
X1	26.90	11.34	2.37	0.141
X2	-13.603	6.838	-1.99	0.185
X3	-0.807	1.746	-0.46	0.689

S = 4.861 R-Sq = 89.6% R-Sq(adj) = 68.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	4	407.32	101.83	4.31	0.197
Residual Error	2	47.27	23.63		
Total	6	454.59			

Source	DF	Seq SS
w	1	269.14
X1	1	37.19
X2	1	95.94
X3	1	5.05

1- Determined equations

$$X_1 = c + b_1 w$$

$$X_2 = c + b_2 w + b_3 X_1$$

$$X_3 = c + b_4 w + b_5 X_1 + b_6 X_2$$

$$X_4 = c + b_7 w + b_8 X_1 + b_9 X_2 + b_{10} X_3$$

where:

X1 = leaves length

X2 = plant length

X3 = Spike length

X4 = Total weight

X1, X2, X3, X4 Endogenous variable

w = wheat

w Exogenous variable

2- Estimated equations

X1 = 12.6 - 0.229 *w*

X2 = 26.0 - 0.717 *w* + 1.52 *X1*

X3 = 1.2 - 0.20 *w* + 0.43 *X1* + 0.20 *X2*

X4 = 313 - 11.8 *w* + 26.9 *X1* - 13.6 *X2* - 0.81 *X3*

3-Estimated:	path coefficients	actual correlation	P-value
b1 (P21)	-0.23	-0.75	0.054
b2 (P31)	-0.72	-0.95	0.001
b3 (P32)	1.52	0.90	0.006
b4 (P41)	-0.20	-0.68	0.093
b5 (P42)	0.43	0.64	0.122
b6 (P43)	0.20	0.71	0.076
b7 (P51)	-11.8	-0.77	0.043
b8 (P52)	26.9	0.76	0.045
b9 (P53)	-13.6	0.76	0.049
b10(P54)	-0.81	0.49	0.265

4- Compare actual and reproduced correlations:

DE

r*12 = (-0.23)[-0.75] = 0.17

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